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WITH the commencement of the New Year the Journal will issue bi-monthly, namely, in January, March, May, July, September and November, while the Special Indian Science Congress Number will cease to appear as a separate issue, papers read at the Congress being published in the ordinary numbers of the Journal. A series of coloured plates illustrating some common Indian birds of interest to agriculturists will be a new feature of the Journal.

The rate of annual subscription will continue to be Rs. 6, while the price of single copies will be reduced from Rs. 2 to R. 1-8.

G. A. D. STUART,

Offg. Agricultural Adviser to the Government of India.

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CONTENTS

(Vol. XIV, Part V.)

ORIGINAL ARTICLES

SELECTED ARTICLES

NOTES

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

REVIEWS

CORRESPONDENCE

NEW BOOKS ON AGRICULTURE AND ALLIED SUBJECTS 852

LIST OF ILLUSTRATIONS

Besides, there is one map accompanying Captain Sherrard's paper on "Vegetables during the Mesopotamian Campaign," and a cross section illustrating Mr. Inglis' "Note on Land Drainage in Irrigated Tracts of the Bombay Deccan."

The following Original Articles will appear in our next issue (January 1920).

Some Common Indian Birds. No. 1—The Indian Roller (*Coracias indica*) ..	*T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.; and C.M. Inglis, M.B.O.U.*
Some Labour-saving Devices in Plant-breeding	*A. Howard, C.I.E.; and G. L. C. Howard, M.A.*
A Few Hints on Labelling in Experimental Stations	*T. S. Venkataraman, B.A.*
Some Famine Foods in Ahmedabad ..	*G. P. Pathak, B.Ag.*
A Neglected Source of Sugar in Bihar ..	*M. N. Ghosh, M.A.*

Photo by George Craddock & Co.

COLONEL HENRY THOMAS PEASE, C.I.E., V.D., M.R.C.V.S.
Principal of the Punjab Veterinary College, 1896-1907 and 1912-1919.

Original Articles

COLONEL H. T. PEASE, C.I.E., V.D.

COLONEL H. T. PEASE, C.I.E., V.D., Principal of the Punjab Veterinary College, retired on 20th July, 1919, after 34 years' service in India.

Henry Thomas Pease belongs to an old Yorkshire family, settled near Hull since the reign of Charles I. He is the son of T. R. Pease, Esqr., of Rusholme Hall, and was born in 1862. On leaving school, he took the diploma course at the Royal Veterinary College, London, and after some experience in a large practice in the north of England, he joined the Army and came to India in 1885.

In 1888 he was given an officiating staff appointment as Assistant Superintendent, Horse-breeding Department, and on the conclusion of that duty was posted as Veterinary Adviser to the Punjab Government and Professor in the Lahore Veterinary School. In 1891 he was specially selected as Superintendent of Bacteriological Survey, and posted to the Bacteriological Laboratory at Poona where he assisted Dr. Lingard in his researches into surra in horses. He soon realized that Poona was quite unsuitable for the requirements of a laboratory engaged in the study of contagious animal diseases. He was placed on special duty to select a more suitable site, and eventually chose Muktesar as possessing most of the necessary requirements. He received the thanks of the Government of India for work done in 1893, and was then appointed Assistant Inspector-General and placed in charge of the cattle and disease branch of the department, a post which enabled him to devote considerable time to the development of the laboratory and at the

same time to direct attention to cattle-breeding and the organization of the department for the treatment of disease in the districts. In the former direction he commenced to collect information regarding the good breeds of cattle, and prepared reports on the indigenous breeds in the Punjab, Mysore, Nellore, and Harriana, all of which were published in manual form. He also prepared a horse-breeding manual which was issued by authority and for which he received the thanks of the Government of India. In regard to disease he endeavoured to stimulate research and the publication of up-to-date manuals on rinderpest, anthrax, hæmorrhagic septicæmia, black quarter, horse surra and ulcerative lymphangitis. He was also the compiler of the "Agricultural Ledger" on breeding, disease and cognate subjects.

In 1896 great difficulty was experienced in obtaining a Principal to succeed Col. Nunn at the Punjab Veterinary College, and he volunteered to give up his appointment as Assistant Inspector-General to take up the work. But although Col. Pease left the Government of India, he remained their unofficial adviser in important matters connected with animal breeding and disease.

At the Punjab Veterinary College, he set himself to work to improve both teachers and students. He set about the preparation of text-books in Urdu himself and stimulated other teachers to do the same. He prepared books in Urdu on equine medicine, equine surgery, soundness and age, horse shoeing, handling of animals, veterinary jurisprudence and contagious diseases. In addition to this, he started and kept going for some years an Indian veterinary journal in Urdu. The present high reputation of the Punjab Veterinary College must be largely attributed to the excellent work of Colonel Pease. In 1905 he discovered the existence of a serious contagious disease among the horse-breeding stock, proved its contagious nature and demonstrated the cause. This was dourine, from which a great number of the stock were suffering, a disease which had doubtless for a considerable time made the results of the horse-breeding operations so bad. He also discovered the existence of hæmorrhagic septicæmia among cattle and buffaloes, and

as instrumental in bringing about the appointment of a Camel Specialist to deal with the diseases of that useful transport animal. In 1906, in collaboration with Baldrey and Montgomery, Colonel Pease started the "Journal of Tropical Veterinary Science," and until 1909 when the collaborators left India, carried on the work for four years practically single-handed. In 1906 he was awarded the title of C.I.E. for work done for the Government of India. In 1907 Colonel Pease was appointed to the post of Inspector-General of the Veterinary Department. He held the post until 1912, when the appointment was abolished, and then returned to the Punjab Veterinary College as Principal. On his return to Lahore the necessity for moving the college to another site had arisen, and he was called on to plan and equip the present new college, which he has made one of the best in the world.

The work which he has done is well known to scientists in all parts of the world and recognized by them. He was made a Foreign Correspondent of the Société de Médecine Vétérinaire in Paris and a Titulary Member of the Société des Sciences Vétérinaire. He is also a member of the Zoological Society of London. He was for many years a member of the Board of Scientific Advice.

In the midst of a busy life he has found time to devote to volunteering, and has for over 20 years been a member of the Punjab Light Horse, of which he was for years Adjutant and eventually Commanding Officer. The verdict of his comrades on his retirement was that his history was the history of the Corps. For his services in the Punjab Light Horse he was awarded the V. D. and appointed Honorary Aide-de-Camp to the Commander-in-Chief in India. For the services he rendered in connection with the Indian Defence Force in the war he was mentioned in despatches by His Excellency the Commander-in-Chief for valuable services rendered during the first three years of the war.

Colonel Pease is a distinguished Freemason at the head of the Craft, Chapter and Mark Degrees in the province

The cheery humour and sound common sense displayed by Colonel Pease at successive meetings of the Board of Agriculture have endeared him to all officers of the present generation in the Veterinary and Agricultural Departments. The best wishes of all follow him into his well-earned retirement. [G. A. D. S.]

PLATE XX.

Photo by Vernon & Co., Bombay.

The late ARTHUR WILFRED SHILSTON, M.R.C.V.S.,
Second Bacteriologist, Imperial Bacteriological
Laboratory, Muktesar.

THE LATE ARTHUR WILFRED SHILSTON, M.R.C.V.S.

By the death of A. W. Shilston, from acute glanders, at the e..y age of 34, veterinary science in India has lost one of its most p..mising and valuable workers. In research and in routine work Shilston gave of his best. He had the true gift for research fore-.ght and rational imagination coupled with patience, perseverance and an infinite capacity for attention to detail. In routine he was ..ompt and resourceful. In both of these fields of work India is ..ply indebted to him.

Shilston entered the Royal Veterinary College, London, in ..ober 1904, and took his diploma in July 1908. His college ..eer was brilliant and he was a marked man from the time he ..ered. Shortly after obtaining his diploma he was appointed .the Veterinary Research Laboratory at Pietermaritzburg, Natal, ..as Assistant to Colonel Pitchford, and subsequently in charge. March 1914, after a brief period of five weeks spent in England, . took up the appointment of Assistant Bacteriologist at the ..ktesar Laboratories under Colonel Holmes. From February ..15 till October 1916, Shilston officiated as Imperial Bacterio-..gist, and afterwards held the appointment of Second Bacterio-..gist, up to his death.

In Africa Shilston did valuable work in connection with sheep ..ab, piroplasmosis, East Coast fever, and the production of anti-..ake-venom serum. In India his energies were devoted to ..oblems connected mainly with rinderpest, surra and dourine, ..d much valuable work in these subjects stands to his credit. ..ilston first became ill on June 17th, and as he failed to make ..tisfactory progress he was sent on to Naini Tal on the 21st. The ..sease from which he was suffering steadily progressed and ..minated fatally on July 6th. It can truly be said that his life ..as sacrificed to his work. [A. L. S.]

THE REPORT OF THE INDIAN COTTON COMMITTEE.

BY

FRANK NOYCE, I.C.S.,

Secretary to the Indian Cotton Committee.

THE issue of the Report of the Indian Cotton Committee is something of an event in the history of Indian agriculture. For the first time, the present position and future prospects of one of the great Indian staple crops has been exhaustively examined by a Committee of experts. An article on the Report in a Journal which is devoted to Indian agriculture is no more than its due, but the writer could wish that it had fallen to the lot of some one more competent than himself to contribute it. The Secretary of a Committee is, for obvious reasons, singularly ill-fitted to criticize its conclusions. All that can here be given is, therefore, some brief comments on the outstanding features of the Report so that any reader of this Journal who has not yet seen it may know what to expect.

The Report opens with an introductory chapter which gives an outline of the general position in regard to the world's supply of cotton which led to the appointment of the Committee. It also gives a brief description of the Committee's wanderings round India which extended from Lyallpur to Tuticorin and from Karachi to Calcutta. The Committee can claim that no important cotton tract was left out and that they visited many places in which no Imperial Committee had set foot before. In these pages, an expression of their grateful thanks for the hospitality which was showered on them everywhere, especially by officers of the

Agricultural Department, may perhaps be permitted. The Report proper is divided into two parts, the first of which deals with the agricultural and irrigational aspects of the problems which confronted the Committee and the second with their commercial aspect. The first part is again divided into chapters in which the cotton growing provinces and Indian States are dealt with separately, and ends with some general recommendations regarding agricultural work on cotton. The second part contains four chapters only, a lengthy one on general commercial questions, more especially the question of preventing malpractices in ginning and pressing factories, one on cotton forecasts and statistics, one in which the establishment of an East Indian Cotton Association in Bombay, which will supersede the present Cotton Contracts Board, is recommended, and another in which the formation of a Central Cotton Committee to act as a link between the Agricultural Department and the trade is advocated.

The summary of the views and recommendations in the Report occupies fourteen pages of the octavo edition, sufficient evidence of the detail into which the Committee have entered. Whatever view may be taken of their proposals, there can be no question that the Report is a mine of information on all matters relating to Indian cotton.

The problem which the Committee set out to solve may be briefly described as being to secure an improvement in the quality and outturn of Indian cotton and at the same time to secure for the cultivator a better price for his improved product and increased outturn. The ways in which this problem can be solved as revealed in the Report are by more research work, especially on the botanical side, improvements in agricultural practice, the provision of irrigation facilities, better organization, the prevention of malpractices which lower the reputation and *ipso facto* the price of cotton, and last, but by no means least, closer co-operation between the Agricultural Department and the trade.

Of all the methods by which an improvement in the quality and an increase in the outturn of Indian cotton can be secured, the most important is botanical work, and the first point which strikes

the reader of the Report is the success of the efforts which the Agricultural Department has already made in this direction. In the Punjab, the United Provinces, the Central Provinces, Madras and the Broach, Kumpta Dharwar and Khandesh tracts of Bombay, it has already evolved strains of cotton superior to the local varieties in staple, yield or ginning percentage (that is, percentage of lint to the total output of lint and seed) and, often, in all three. The Central Provinces with their 700,000 acres under *roseum* offer the best example of what such work has done to improve yield and ginning percentage, the Punjab with its 276,000 acres under Punjab-American and the Tinnevelly tract in Madras with its 220,000 acres under *karunganni*, the best examples of what it has done to improve staple as well. The staple of *karunganni* is at least an eighth of an inch longer than that of the mixture known as Tinnevellys and its ginning percentage is some 5 per cent. higher. The staple of Punjab-American is about $\frac{1}{4}$ to $\frac{3}{8}$ths inch above the average of the indigenous cotton of the Punjab and, though its ginning percentage is much the same; its yield is much heavier so that the outturn of lint is much greater. In the other tracts in which the Agricultural Department has evolved superior strains, they have been literally in the field too short a time to "catch on" in the way that *karunganni* and Punjab-American have done. In the Broach and Kumpta Dharwar tracts of Bombay, they have made but little headway. One difficulty has been the lack of a suitable organization to push them. The breakdown of the Surat buying Syndicate which was formed by some of the Bombay mill-owners proved very detrimental to cotton improvement work in Bombay. Another obstacle to rapid progress is the fact that Broach and Kumpta cottons are varieties of *herbaceum* which, as pointed out in the Report, is possessed of very stable characteristics. It is, therefore, difficult to secure anything in the nature of a recognizable improvement in it. This also applies to the Westerns cotton of Madras. In that tract and in the adjacent Northerns tract, the Agricultural Department has put out two improved strains, Hagari No. 1 and Sircar No. 2, but their superiority over the local cotton has not been sufficiently marked to justify perseverance with them and it is, therefore,

proposed to make a fresh start with two other selections, No. 25 in the case of Westerns and No. 14, an especially fine strain, in the case of Northerns. 4 F does not represent the last word in American cotton for the Punjab and the Committee recommend further experiments with 280 F and 285 F, strains which it may be of interest to mention have proved exceedingly successful in Captain Thomas' experiments in Mesopotamia. The Committee, again, are not satisfied that *roseum* in the Central Provinces and Khandesh and Aligarh white-flowered cotton in the United Provinces represent the *ultima thule* of the Agricultural Department, and are anxious to see further efforts made to evolve a superior variety of *neglectum* or *indicum* or a cross between them which can compete successfully with *roseum* or Aligarh white-flowered cotton in the matter of profit to the cultivator whose interests, it may here be stated, have been the predominating consideration with the Committee throughout. It will be seen that there still remains a vast field for botanical work in tracts in which superior strains have already been evolved. There are also large tracts in which no botanical work has yet been done at all. Hyderabad, which produces over one-seventh of the cotton grown in India, is the most important of these. Others are the Coconada tract in Madras and the Dholleras tract in Bombay. Very little work has been done on the indigenous cottons of the Punjab, and the Committee regard botanical work on Cambodia as the most urgent of the problems affecting cotton in the Madras Presidency. Burma is also practically untouched. The ten botanists the Committee recommend should be added to the Agricultural Department for work on cotton will thus find ample employment. This addition will enable more attention to be paid to crossing, the possibilities of which have been revealed by Mr. Leake's important work at Cawnpore.

Improvements in agricultural practice tend more to an increase in the outturn of cotton than to an improvement in its quality. It is too much to expect that the 85 pounds of cleaned cotton which is all that India produces to the acre will ever be increased to 200 pounds per acre as in the United States but much of the leeway can doubtless be made up, if the detailed recommendations made by the

Committee after careful examination of the conditions in each province, are carried out. The most important improvements advocated are the spread of the practice of sowing in lines and of inter-culture and the working out of suitable rotations which should include, wherever possible, heavy yielding leguminous fodder crops.

Extensions of irrigation are of special importance in the case of cotton for, in addition to the increase of acreage and outturn they secure, they also mean an improvement in quality. The increase in acreage is an obvious result, for such extensions permit cotton to be grown where it was not grown before. The increase in outturn per acre is equally obvious, for irrigated cotton yields more heavily than unirrigated. The improvement in quality is not so obvious but it is secured by the substitution of the better varieties of cotton which require a longer growing season for the shorter stapled ones. Broadly speaking, extension of irrigation means the cultivation of more American cotton for, in the Peninsula in which the longer stapled indigenous varieties are grown, cotton is not an irrigated crop except in the case of Cambodia under wells in Madras. Of the three great cotton-growing provinces of the north of India, Sind holds out the greatest possibilities and up till now has the poorest performance. Fifteen years or so ago, 200,000 acres of Egyptian cotton were expected in the course of a few years. In 1917, practically no American cotton was grown except on the Government farms. The Committee have no hesitation as to the cause to which this disastrous failure to realize expectations is to be ascribed and the whole of the chapter on Sind is a powerful plea for the immediate construction of the Sukkur Barrage across the Indus which would "transform some four and a half million acres of culturable land, at present sparsely populated and indifferently cultivated, into one of the richest and most productive tracts in India." It would incidentally result, according to the Committee's very moderate estimate, in an area of 660,000 acres under cotton, of which about two-thirds should be cotton of longer staple than any at present grown in India, not excepting the best Cambodia, and at least 1¼ inches in length. If the yield were no more than 160 pounds of lint per acre which the Report states is the outturn

of irrigated lands in the Punjab, this would mean an addition to India's supplies of long staple cotton of 160,000 bales. In the Punjab, the Committee anticipate a total of 465,000 acres under American cotton under existing canals in the course of two or three years against a total area of 276,000 acres in 1917, and a further addition of 200,000 acres if three big irrigation projects under contemplation are carried out. Outside Sind and the Punjab the prospects of long stapled cotton under irrigation are much more nebulous. The area under American cotton in the United Provinces *might* increase from the few thousand acres at present to 135,000 acres under the Ganges and Agra Canals, provided a sufficiently high premium for it could be assured. The addition of the proviso shows that the Committee were not very hopeful about American cotton in the United Provinces and that there is uphill work in front of the Agricultural Department in those provinces if it is to succeed. There are some small possibilities for Punjab-American in the North-West Frontier Province, for Cambodia on the lateritic soils in the east of the Central Provinces and for Cambodia or Upland Georgian on lands which formerly grew poppy in Central India. The cultivation of Cambodia under wells should spread in Madras but it is impossible to make any estimate of the prospects as no survey of suitable lands has been carried out. The only recommendation in the Report in regard to indigenous varieties under irrigation is that liberal *takavi* advances should be granted for the construction of wells in North Gujarat where greatly increased yields have been obtained in the Kaira District in such conditions.

The "better organization" which was mentioned at the outset includes the organization both of the Agricultural Department and the cotton trade. To the recommendations the Committee make in regard to the organization of the trade reference will be made later. As for the organization of the Agricultural Department, it will be obvious that if the cultivator is to grow better varieties of cotton and to obtain the proper price for them, he needs all the advice and assistance the Agricultural Department can give him. If "the selection and distribution of pure seed are to be controlled by the

Agricultural Department in the manner best suited to the local conditions of each tract," a large increase in the number of seed farms is necessary. If the Agricultural Department is to demonstrate on the requisite scale the usefulness of improved agricultural implements and to convince the cultivator of the advantages resulting from the use of manures and from good cultivation, a large increase in staff is necessary. Such an increase is, above all, necessary if the Department is to be in the best possible position to assist the cultivator in getting a better price for a superior product. The various ways in which this end can be secured are discussed in the Report. Warned by the fate of the Surat and Sind buying Syndicates, the Committee decide against buying agencies. The prospects of co-operative sale are hopeful but this is an agency the growth of which cannot be forced and something else is required. The Committee, therefore, advocate an extension of the system of auction sales of unginned cotton which has proved so successful in the Punjab, but consider that the Agricultural Department should not in any one case attempt to deal with more than 60,000 maunds of cotton which would give it control over 40,000 maunds of seed. After that, the sales should be handed over to other agencies, but the Department would still be called upon for advice and assistance in regard to such matters as grading, classification and the settlement of disputes. All this means a considerable expansion of what it is now the fashion to call "organization" and the additions to the staff of the Agricultural Department recommended by the Committee, apart from the ten Botanists mentioned above, an Entomologist for the United Provinces and an Imperial Mycologist, are one Director of Agriculture for Sind, thirteen Deputy and Assistant Directors of Agriculture belonging to the Indian Agricultural Service and three Assistant Directors belonging to the Provincial Service. For Indian States, the immediate additions proposed are two Directors of Agriculture and two Deputy Directors. The subordinate staff must, of course, be increased proportionately. The total annual cost of these proposals is estimated at Rs. 14 lakhs, which cannot be considered excessive in view of the importance of the cotton crop to India.

It is of little use for the Agricultural Department to spend its energies in inducing the cultivator to grow pure or superior varieties of cotton and to pick them clean, if he is prevented from securing the proper price for them by malpractices which he is powerless to check. The Committee give the cultivator a good character in this respect and state that the malpractices for which he and the village *bania* are responsible are of minor importance compared with those which are carried on in ginning and pressing factories. The recommendations in the longest and most important single chapter of the Report are directed to securing an improvement in the conditions which have made Indian cotton "a byword in certain markets almost throughout the history of the British connexion with India." The opening of central markets on the Berar system which enables the purchaser of cotton to see what he is buying and to pay for it accordingly, the publication of cotton prices in up-country markets in a way which will enable the cultivator to understand their true significance, and the standardization of weights on the basis of a cotton maund of 28 pounds, which will prevent his being cheated by the middleman, are all measures calculated to bring about the desired effect, but far more important than any of them is the system of licensing ginning and pressing factories which is recommended by the Committee. For the details of this scheme, the reader must be referred to the Report itself. Suffice it to say that, in future, the way of the offender will be very much harder than it has been in the past and that it should no longer be possible to fob off the man who produces a superior variety of cotton with the price of the inferior stuff with which it has hitherto been far too often the practice to mix it. Warned by the history of the Bombay Cotton Frauds Act, the Committee have worked out a scheme which involves the minimum of interference with honest factories. There will be no inquisitorial inspections by poorly paid subordinate officials which was the great grievance against the Bombay legislation. Complaints will be made by the sufferers and will be investigated by Committees on which the trade will probably have a preponderance of representation. If the trade is satisfied with bad cotton and prefers to pay for rubbish, there will, of course, be no

complaints and things will remain much as they are, but it is inconceivable that this should be so. Even if it is, one fruitful source of mischief will be removed for, under the Committee's proposals, the transport of cotton waste or of short staple cotton from one tract to another for the purpose of mixing with better varieties will be prohibited.

The chapter on cotton forecasts and statistics generally is worth study for many of the recommendations in it are applicable to other crops than cotton. Considerations of space prevent more than this brief reference to it.

We mentioned above that the Committee have suggested not only better organization of the Agricultural Department but also of the cotton trade. The way in which they propose that this should be brought about is by the establishment of a Central Cotton Trade Association in Bombay which, as far as control of the cotton trade is concerned, will take the place of the seven distinct bodies representing different branches of the cotton trade which existed at the time the Report was written and still exist, though the functions of two of the most important of them, the Bombay Cotton Trade Association and the Bombay Cotton Exchange, are at present exercised by the Cotton Contracts Board. The "East India Cotton Association" will be the permanent successor of the latter and there can be no doubt that its establishment will have a far-reaching effect in stabilising the price of cotton to the ultimate benefit of the cultivator.

In their last chapter, the Committee make provision for the much needed link between the Agricultural Department and the cotton trade. There can be no question that, valuable as the work which has already been accomplished by the Agricultural Department in improving Indian cotton, it would have been much more fruitful in results had there been closer co-operation between it and the cotton trade. Up till now, each of them has been amazingly ignorant of what the other has been doing. It would be an unprofitable task to apportion the blame for this. As the Irishman said when asked why an unpopular landlord had not been shot, what is everybody's business is nobody's business. There will, it

future, be no excuse for ignorance, for all interested in cotton, whether agriculturally or commercially, will be able to turn to the Central Cotton Committee for advice and assistance. It is proposed that this Committee should consist of about twenty members of whom nine will be officials. These will be the Agricultural Adviser to the Government of India who will be President, six agricultural experts working on cotton in the six great cotton-growing provinces, the Director General of Commercial Intelligence and the Director of Statistics. The remaining members, with the exception of a representative of the Co-operative Department who may be either an official or a non-official, will be representatives of Chambers of Commerce and similar bodies and will include a representative of Lancashire interests. Though the functions of the Committee are to be almost entirely advisory, its advice will be the best expert advice obtainable and will be of special importance in regard to the working of the system of licensing of gins and presses, as the penalty of withdrawal of the license of an offending factory will be inflicted on its recommendation. The Agricultural Department will no longer be in the dark as to what the trade really wants nor, as has been the case very frequently in the past, will it be confronted with conflicting reports as to the value of its improved strains. The services of the Technologist whom it is proposed to add to the staff of the Committee will be very valuable to it in the latter connexion. It should be mentioned that the Central Cotton Committee will work to a large extent through provincial and local sub-committees. If it becomes an accomplished fact, it should lead to an immense development of one of the most important raw materials which India produces.

MOTOR TRACTOR TRIALS AT PUSA.

BY

WYNNE SAYER, B.A.,

Offg. Imperial Agriculturist.

It being clearly evident from reports received from home that a type of motor tractor for agricultural work had been evolved which was capable of doing excellent work under ordinary farm conditions, arrangements were made to secure the first tractor imported into India of the type most likely to suit Bihar conditions in order that a trial might be undertaken on the farm at Pusa for the benefit of the agricultural public. The Fordson was chosen for four very obvious reasons :—

1. It was light and handy.
2. It was fully supplied with spares.
3. It was likely to be available very shortly, it was cheap and if the demonstration was successful no difficulty would be experienced in procuring others.
4. It had done excellent work in all hards and under all conditions in England and was obviously a type of tractor which had been thoroughly tested.

It will perhaps be best to give a description of the Fordson here which, coupled with the photographs (Plates XXII-XXV) should make its details fairly clear to all.

The Fordson motor tractor is so constructed that the engine and all the working parts form the frame of the machine. A unit "Power Plant" is bolted to and forms a unit with the rear axle in the shape of a big T. In this T are stowed all the working parts.

PLATE XV.

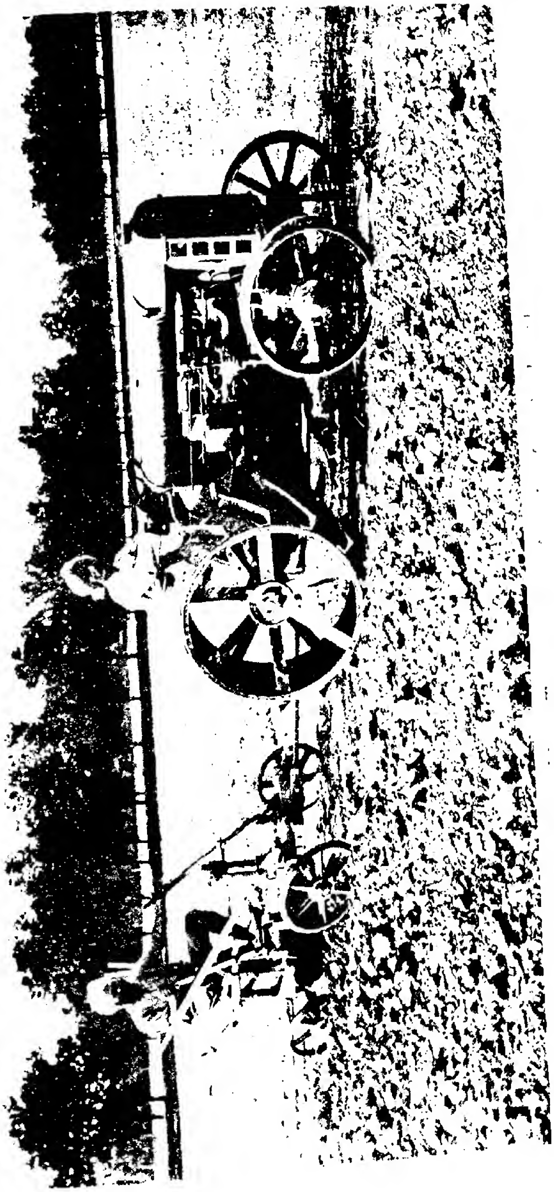


PLATE V

The T is mounted on four solid wheels. The wheel base is 63 inches and the tread is 38 inches. The tractor will turn in a 21-foot circle. The rear wheels are 42 inches in diameter with 12-inch rims. Overall length is 102 inches, height 55 inches and width 62 inches. The total weight of tractor is 2,700 lb. with water and fuel tanks filled, which hold 11 gallons and 21 gallons respectively.

The tractor can be used for a double purpose—both for hauling and ploughing. Its capacity as regards the latter is two 14-inch ploughs which are hauled at $2\frac{3}{4}$ miles per hour with the engine running at its normal speed of 1,000 r.p.m. The drawbar pull at ploughing speed is 1,800 pounds, which is increased to 2,500 pounds at low speed of $1\frac{1}{2}$ miles per hour. For road work and running light from place to place, there is a speed of $6\frac{3}{4}$ miles. The reverse is $2\frac{1}{4}$ miles an hour. For stationary work, a pulley is fitted on the side of the tractor and operated from the engine clutch. Twenty two horse power is available at the pulley which runs at 1,000 r.p.m. The pulley is 9 inches in diameter and uses a six-inch belt.

The engine has four cylinders, each 4×5 inches. Petrol is used for starting, and when the vaporiser is sufficiently heated, kerosene can be substituted. The consumption of fuel varies naturally with the conditions, but is said to be not likely to exceed $2\frac{1}{4}$ gallons of kerosene per hour on the average. When the engine is at stationary work and running on full power, the consumption amounts to two and three-quarter gallons per hour.

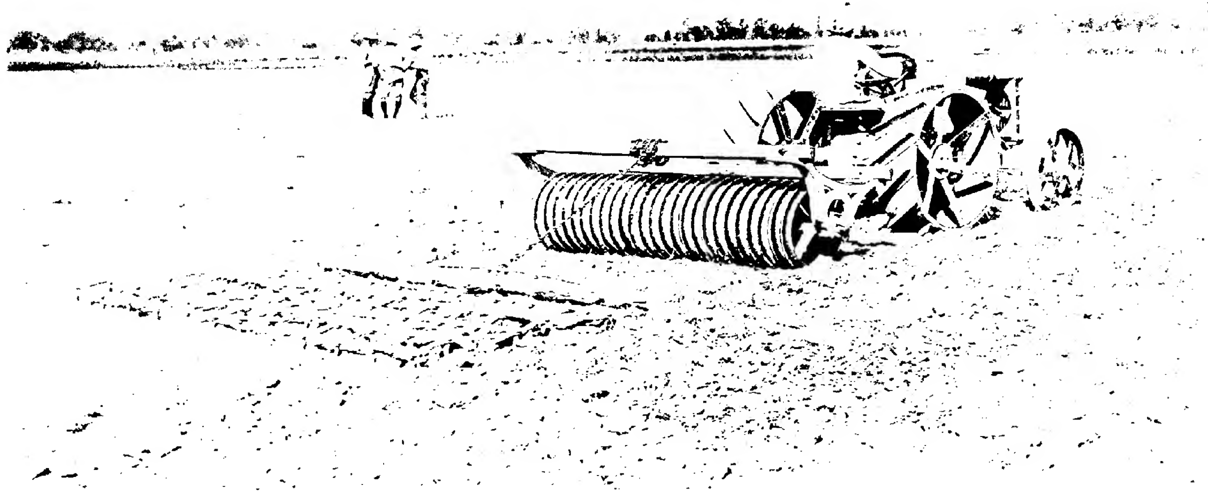
The cost of the Fordson tractor is Rs. 1,250 f. o. r. Calcutta, and the Russa Engineering Works, Ltd., Calcutta, are the agents in India.

The tractor unfortunately arrived in India without any of the implements with which it was meant to be worked, but as it was all important to get some idea of its powers under Indian conditions (the quality of the work done being purely a question of the implements used), it was decided to use it with the implements available on the farm which, not having been designed for tractor haulage, made the test extra severe.

The tractor was worked on the farm for some days previous to the trial in order to familiarise the farm staff with it.

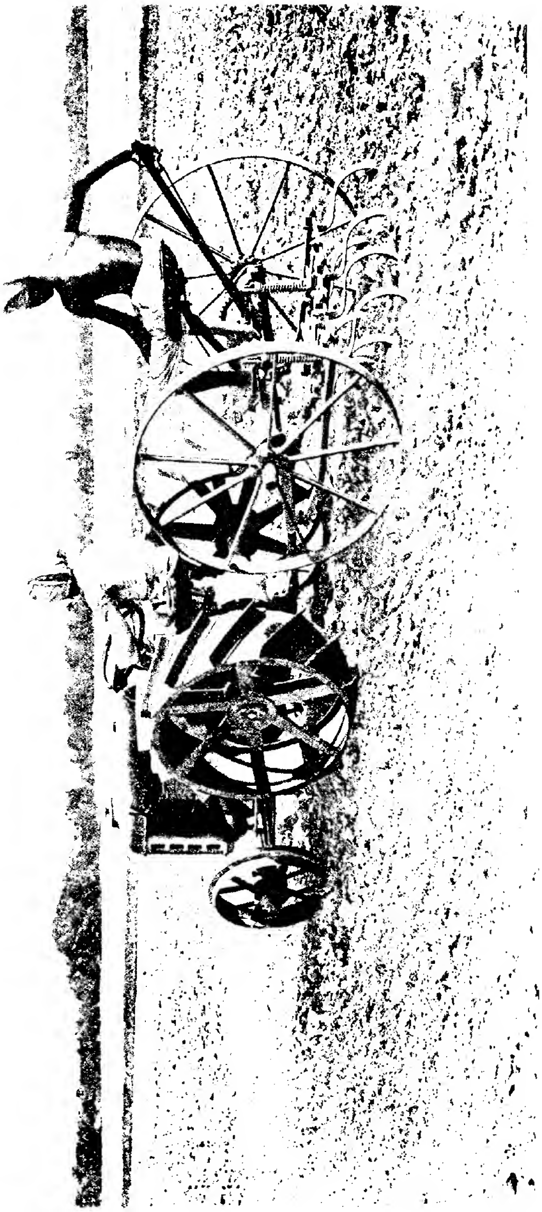
It was a welcome surprise to find from the start that at last an agricultural motor had been evolved which was obviously designed by some one who did really understand what was essential in dealing with agricultural conditions. Previous experiences in this line had shown us that whatever might be said in pamphlets, up to the introduction of the Fordson, no motor had been tried in India which would work under ordinary agricultural conditions; but here there was a total absence of the wild ideas about Indian conditions usually incorporated in agricultural machinery imported into India. The tractor proved easy to handle. The engine was exceptionally accessible in all parts (what this means, only people who have had to do running repairs to an American engine can tell). It was undoubtedly powerful, exceptionally handy and easy to drive; and as soon as the method of starting on petrol and the switching over on to kerosene had been explained, there was nothing else that the average *mistri* with a small knowledge of motor cars could not easily grasp; and once all those who drive a Fordson have found out by personal observation that if you let your clutch in too quick when in a bad place, the tractor rears up, you do not need to repeat the warning. This is the only risk other than those inseparable for the average moving vehicle and must be carefully guarded against and I would take this opportunity of warning all users of Fordsons in India about it. Some means of switching off the engine directly the tractor starts to come up, will have to be found, as a machine of this lightness and power will always wind itself up on its back axle under such circumstances. There is also a chance of burning out the vaporising tube if you allow the engine to run too long on petrol before switching over, and some means should be invented of cutting off the supply of petrol before this can happen in cases where, either from ignorance or accident, the engine is left running on petrol too long. A spare vaporiser tube should also be kept handy, and with the usual couple of spare plugs in reserve, no trouble should be experienced in running, provided the usual care is taken with oil and water supplies.

The land chosen for the trial was a piece of typical oat stubble which, owing to the continuous dry weather, had worked down pretty



Motor tractor working Cambridge roll and rake of spring tooth harrows

PLATE



land. A piece of land, 400 yards × 20 yards, was marked out for the ploughing and another similar strip for the cultivator.

The tractor was first hitched to a double-furrow Ransome's disc plough which is pulled as a rule by three pairs of big bullocks. It worked this easily, the engine running with a good reserve on second speed and the way in which tractor and plough turned on the small head land was remarked by every one. Judging from the pace at which the work was done and the reserve which the tractor had in hand, it seems that it will be possible to do the class of ploughing required on such lands with a three, instead of a double, furrow plough.

A Ransome's 8-spring tined cultivator was then attached and another strip was grubbed at a depth of 5 inches. The way in which this work was done was especially notable for the ease with which the cultivator worked the land and the rate the tractor travelled at, and many present thought this method of dealing with stubble to be preferable under Bihar conditions to ploughing. The work done by such an implement, working 3 feet wide with 8 tines, approximates to that of the average iron plough used which while loosening does not invert the soil, while the breadth covered by the cultivator at each run is equal to 5 ploughs.

A rake of 3-spring toothed harrows was then run over the ploughed portion and much interest was displayed at the way the tractor travelled over a loose surface, showing no sign of poaching or failure to grip the soil.

A Cambridge roll was then worked over the ploughed land and the remarkable efficiency coupled with the extreme lightness and handiness of the tractor, became evident. She travelled over the ploughed land easily and quickly, doing the work perfectly efficiently and finding no trouble from the depth and looseness of the soil, and the driving wheels, while breaking up the clods, did not pack the land at all. The tractor was very carefully watched with regard to this as it has been the chief thing to be feared with a mechanical prime mover working over the land.

The tractor was then run off the land and driven on top speed up to the farm buildings where the driving pulley was fitted and the

Climax silage cutter worked for half an hour. The engine took the load easily and ran regularly and steadily. Despite the extreme heat of the day, at no time did the water in the radiator approach boiling point, and the method by which the air taken into the carburetter is filtered through water, enabled the tractor to work in the heaviest dust without any choking. In short, the demonstration and trial, as far as proving the capabilities of the tractor went, were perfectly satisfactory. It now remains to test the tractor for fuel consumption, etc., and to watch its behaviour and work over a period in the hands of the average *mistri*. Tests to this end together with trials of the most suitable implements, especially for Bihar conditions, will be conducted, and I would take the opportunity of replying to all—and their number is legion—of the people who have spoken and written to me about this tractor as follows :—The tractor is under trial and I can express no opinion and give no figures yet but a report will issue in due course. A set of photographs taken by the cinematograph (Plate XXVI) illustrate this article showing the machine at work, and I shall be only too glad to show any one the machine working any day if they will write to me and fix a date.

I hope in the near future to have an engineer working in collaboration, as these experiments will require combination of engineering and agricultural knowledge to enable them to be thoroughly and satisfactorily carried out.

Motor tractor trial views from cinematograph film.

VEGETABLES DURING THE MESOPOTAMIAN CAMPAIGN.

BY

CAPTAIN G. C. SHERRARD,

Deputy Controller (Agricultural Requirements, Mesopotamia). Indian Munitions Board.

U is the lake known as Um-el-Brahm
Which guards our left flank from all possible harm
And waters old Gomigee's barley farm
In the middle of Mesopotamia.

Mesopotamian Alphabet.

I BEGIN with the above quotation from that delightful doggerel the Mesopotamian Alphabet, because it is the first popular reference to agriculture made by the army in Mesopotamia. Unfortunately I can find no one who can tell me who Gomigee was, or where his farm.

I should like to talk about the Mesopotamian Alphabet, because I believe it contains, if read with sympathy, a real guide to the spirit of the old army, the army that fought its way under great difficulties to Ctesiphon, and nearly to Baghdad. The men who knew that things were going wrong, but, because soldiering was their "job," did not rave, or stop,—they joked. In the Alphabet the laugh at the ruling powers has something of an edge, but that at individual services is good-natured chaff, without a sting. The army that produced the Alphabet knew that the medical service was ill-equipped, that the transport was breaking down; but it also knew that the individual doctor was working night and day, that single transport officers were trying to do alone work that was later given to four or more, paying in mind and body for the strain. All this was changed. When I arrived the change had well begun; but I heard and saw enough to make me realize what went before.

Later, a new generation arrived, while conditions altered greatly; so the Mesopotamian Alphabet was very near forgot.

This, however, is not a paper on Mesopotamia, or the army, old or new, but only an account of the work of a branch of the Indian agricultural department, planted out behind that army in the field. It is unfortunate that the account contains so much of the letter I, but, as I have been asked to write a description of my work, and have not the necessary literary skill, I have had to do it the easiest way—and I ask for your indulgence.

I believe that Mr. Maxwell-Lefroy first suggested that a member of our department should go to Mesopotamia to grow vegetables and help to fight scurvy, when he returned from a tour in that country undertaken to advise on the destruction of flies. The proposal was seconded by Mr. Mackenna, and, I am glad to say, I was chosen for the work.

On August 13th 1916 I received a copy of a letter from the Government of India, which said, "it is proposed, with a view to obtaining supplies of fresh vegetables for the troops in Mesopotamia that the Agricultural Department in India should assist in the introduction into that country of vegetable cultivation by lending to the Army Department the services of a Deputy Director of Agriculture with a staff of *malis*, and that Mr. Sherrard * * has been suggested as the most suitable * * if * * (he) is willing to undertake the duty * * (he) should be instructed to engage twelve *malis*." This raised many questions; but chiefly, two. What, exactly, was expected; and, why twelve *malis*? A visit to Simla did not elucidate matters to any great extent. There was an unformed idea that a vegetable farm should be started, but no explanation as to the reason for the precise number of twelve *malis*. The most definite statement was that of General Bingley, who said, "There are 175,000 men in Mesopotamia, and hardly any vegetables." Perhaps no one else put the facts so plainly for fear of scaring me out of my wits, even as it was I had a strong impulse to fly, and bury myself in the uttermost wilds of Bihar.

The next step was to collect the twelve *malis*. In these excellent market gardeners, the *koiris* round Bankipore, I thought I had

exactly the right material to my hand. But the *koiri* is timid, painstaking, and averse to leaving his native home (for which reason he is much sought after by landlords), and, though I had no difficulty in finding twelve good men, nothing would induce them to go to Mesopotamia, and they invariably bolted the day before they were to be entrained. It was very much like taking a sieve of oats to catch twelve shy colts loose in a large field. Obviously it was more important to find out what was happening to the 175,000 men with no vegetables, than to waste time endeavouring to overcome the coy reluctance of the *koiris* of Bihar. So I proceeded to Bombay.

There, and at Poona, through the good offices of the Director of Agriculture and the Economic Botanist, I was able to collect seven out of the twelve *malis*, and to make arrangements for vegetable seeds to be sent out to me from India as required. I then left Basrah, where I arrived on September 16th 1916 and reported Brigadier-General P. C. Scott, C.B., Director of Supplies and ansport, Mesopotamian Expeditionary Force. After some conltation, it was arranged that work in connection with the producon of vegetables should become part of the S. & T. organization, ud I was put under the orders of the D. S. & T.

It was now that I fully understood what was expected of the gricultural expert. Scurvy cases were being admitted to the ospitals at the rate of 3,000 a month, and evacuations and deaths ere very numerous. There was a definite hope, therefore, that fficient vegetables would be produced, to provide everyone with he regulation daily ration of 12 oz. of fresh vegetables for British nd 6 oz. for Indian troops, and to stamp out the disease. Howver, though this was the object to aim at, the authorities were quite illing to admit that it was difficult to obtain, and that the full ation could only be raised with time, if at all. Their attitude, and articularly that of General Scott (with whom I dealt direct), was xtremely helpful, and created a pleasant atmosphere to work in. It was as if they said : " You understand that the position is serious. As an agriculturist you will know best how to produce the vegetables. We will not interfere, or hamper you, and will give you what you

ask for (as far as this is possible among the conflicting demand many important works); and then we hope for results." This the army way, and it is a pity that it is not more common in c life.

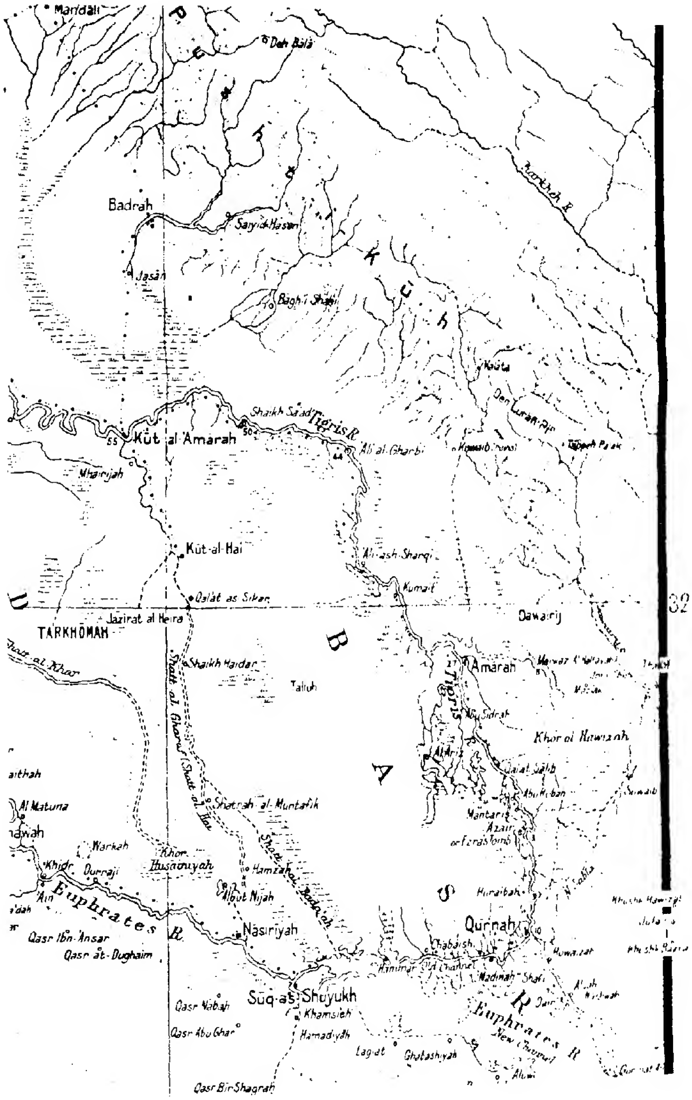
Later on arose the question of my official title. "What sh we call you?" "Anything that you think will do." "What w you called before, in your own service?" "A deputy-director agriculture." "Well, that is quite a good name, go on call yourself that, unless someone objects in the future." And so became, temporarily, an official title in the S. & T. Corps. It w interesting—and, perhaps, amusing—to be the first deputy-direc of agriculture ever attached to a British force in the field. T *following pages attempt to show the doings of this small agricultu* department up to the end of 1917, when it passed over to ci administration, and its story more properly belongs to the ear history of the Mesopotamian agricultural department.

I. Before the advance.

You all know the position in Mesopotamia in September 191 and here (as elsewhere in this report) it is only recalled sufficient to explain what follows.

The army was holding the lines at Sannayat and Sinn, on bot banks of the Tigris, and its supplies were sent up the river 243 miles, by steamer and barge, from Basrah to the advanced base a Shaikh Saad. From there they went, either by a light railway o the right bank, or by smaller boats to Arab Village, 22 miles furthe up the river.

The facilities for unloading the steamers and loading the rive barges at Basrah were improving with almost marvellous rapidity and continued to improve. But the railway from Qurnah to Amara had not yet been built, and the whole line depended upon the rive craft, a miscellaneous collection of paddle-boats and tugs, that ha been recruited from all corners of the Empire. East Indian Railwa boats, that had ferried the ryot across the Ganges; stern-wheele that had taken the tourist up the Nile; London County Counc boats, that had carried the cockney on the Thames; Irrawady boat



Mandali
Deh Bālā
Badrah
Saiyid Hasan
Jasān
Bāgh-i Shāhi
Shaikh Sa'ad
Tigris R.
Kūt al Amārah
'Ali al Gharbi
Mhairijah
Kūt-al-Hai
'Ali ash Sharqi
Kumait
Qal'at as Sikar
Jazirat al Heira
TARKHOMAH
Dawairij
Shatt al Khar
Shaikh Haidar
Shatt al Gharaf
'Amārah
Abu Sidrah
Khor al Hawizah
Qal'at Sālih
Al Matuna
Shatrah al Muntafik
Warkah
Khor Husainiyah
Khidr
Durraji
Hamzah
Euphrates R.
Nāsiriyah
Qurnah
Chabaish
Qasr Ibn Ansar
Qasr at-Dughaim
Qasr Nabah
Sūq-ash Shuyukh
Khamsieh
Hamadiyah
Qasr Abu Ghar
Qasr Bir Shagrah
Euphrates R.
New Channel
32

from Burma; harbour tugs from Rangoon: all now painted the same light grey, each with a couple of barges, toiling up and down. Their numbers were constantly being increased, but none of those specially built in England for the work had yet arrived, and the cry was always for more.

The advanced base at Shaikh Saad was a large, long camp on the right bank, with a tiny uninhabited Arab village tucked away in one corner of it,—aerodrome, hospitals, rest camp, troops, ordnance, supply depôt (largely supply depôt), a bridge of boats, and a bridge-head on the other bank; the whole protected on the landward side with defence posts and continuous barbed wire. To a new arrival the general impression of the place besides dust was of innumerable gangs of khaki-clad men slowly carrying boxes and bales from barges and dumping them on the foreshore. Sometimes they were fatigue parties, but usually they were coolies men of the porter corps. No Arab was allowed within rifle shot of the place (though he often crept in, uninvited, at night, to steal and occasionally to stab), and all the work was done by the force. Though the labour and porter corps were steadily increasing, there was not then, nor for a long time, enough labour to supply the various demands; every cooly might almost be said to be fought for among the many departments demanding his time. But all this was on paper, the actual individual went on quietly carrying his box of biscuits to the shore, or his basket of earth to the bund, without showing any particular concern.

Having completed the journey to Shaikh Saad, a report was made on the possibility of importing potatoes and onions from India. Various attempts to do this had been made in the past but without success; nor was this to be wondered at, judging by the stories of the men on the ocean-going steamers and the river craft. The potatoes had been packed in sacks, treated as ordinary cargo, and placed in the hold, sometimes with other goods on top of them. They then had to be transhipped at Basrah, first to the shore and then to the barges, where they were again heaped up. I was assured that in some cases they were half rotten before they left India, they were certainly often bad before they reached Basrah. It was,

therefore, suggested that potatoes should be carefully selected and picked over in India, packed in crates, kept ventilated and unbruised, treated as perishable goods, and sent up the line with despatch when it should be possible to supply the force, without a prohibitive loss, for the greater part of the year. One or two other letters and suggestions were submitted on the subject, and the authorities in India took the matter up. The result was a very great improvement, so that even in the heat of June 1917, potatoes were arriving as far up the line as Samarrah, 70 miles above Baghdad, with a loss of less than 50 per cent. in transit ; a journey which, measured in time, is probably the longest that potatoes have ever been sent in large quantities. A loss of 50 per cent., however, was too large to make it worth while importing potatoes during the hot weather, and the export from India was stopped during May ; it being arranged that in future potatoes should not be shipped between the end of April and the middle of September. Onions were received throughout the year but, as the local supply of fresh vegetables increased, the quantities were gradually reduced, and the importation ceased at the end of 1917. Though there was a very rapid improvement in this supply, there were, of course, mistakes at first (for example, furious wires were flashing about, in December because numbers of potatoes were still arriving crushed in sacks, in January because some harassed officer had sent them up the line in country boats, which took ten days to reach Amarah alone, where the potatoes arrived bad), but these were gradually almost entirely eliminated, and were due, as were similar incidents in other branches of the work, not to any difficulty in convincing those in authority of what was required, but to the impossibility of educating a large number of hard-worked and constantly changing juniors in the correct way of treating a travelling vegetable.

The advantage of a vegetable garden at Shaikh Saad had been realized for some time, and four and a half acres had been set aside latterly for the purpose, while two *noiria* pumps had been ordered. Four and a half acres, however, would not go very far, so fifty acres were selected, with some difficulty, for a farm. It was found impossible to obtain more than this, as the area had to be inside the

efences and was further circumscribed by the [illegible] nd the salt patches so common along the lower [illegible] ngine and pump, together with various implements [illegible], nd plans drawn up for irrigating and laying out the land. I then roceeded down-stream to Amarah.

Amarah, actually a small place, is the most important town etween Basrah and Baghdad. It is situated 112 miles by river elow Shaikh Saad, at the junction of the Tigris and the Chahala anal. As at Shaikh Saad, the whole place was surrounded by block ouses and barbed wire; but the local Arab was much more encouraged, as he was less obstreperous. True, he was instantly fired at f seen by the sentries outside the perimeter at night, while if he lived in the town he was encouraged to go to bed at an early hour, but during the day he was allowed to wander about almost at will, to attend to his own affairs, to occupy himself with his cultivation or to work for us in the depôt or on the roads.

A second canal, the Mashera, takes off from the Chahala just after the latter leaves the river. There are thus three streams (the Tigris, the Chahala and the Mashera) from which water may be raised to cultivate the land, irrigation from all three being by lift and not by flow, except when the river is in full flood. Several forms of water-lifts and pumps were in use: *noiria* pumps, a wheel with an endless chain of small buckets, worked by a blindfolded pony and a primitive wooden gear; *chereds* (the *mhote* of India), large leathern bags with a trunk at the end, self-discharging, and attached to a diminutive pony or cow that raises the bag by going headlong down an extraordinarily steep incline; even several oil engines and centrifugal pumps. The cultivation is a narrow strip on each side of the three waterways. Near the town a number of date groves, among these and on fields further out the land is put down under barley or wheat; and in and out among the date palms were small patches of vegetables.

On October 13th 1916 a report was submitted giving proposals for carrying out the work which were much the same as those on which it ultimately developed. The area necessary to provide the vegetable ration for the force was very much larger than was

generally supposed, and all ideas that a few acres here or there would suffice must be abandoned. The fifty-acre farm at Shaikh Saad would be put under cultivation as soon as pumps, implements and men were forthcoming, but the main supply must come from elsewhere. If this was grown by military labour, it would require a large number of men, who at present were not available, besides pumps and implements. It was more advisable, therefore, to utilize Arab labour, and to extend the present vegetable cultivation in such places as Amarah and Ali-al-Gharbi, where irrigation facilities already existed, or could be increased on existing lines. To get the best results, however, besides the agricultural side, comprising the general supervision of the crops sown, it was essential that there should be prompt payment in cash for the produce when harvested. Again, as work with the aid of local cultivators, under existing conditions, would have to be undertaken some way behind the lines, it was of the utmost importance that the vegetables so obtained should be collected in one place as soon as possible after harvest, carefully packed, and immediately shipped to the front. The work itself is described below under the three heads, growing, collecting and transporting.

Growing.

There was a general idea that no vegetables were grown in Lower Mesopotamia before the war, and that, therefore, the Arab knew nothing of their cultivation. This was not the case. That there were few vegetables is true, for the marsh Arabs, and those in the smaller villages, contented themselves with a kind of mallow and other plants that grew wild ; and this applies to the poorer classes in the towns. But in Basrah, Amarah and Nasiriyah, fair quantities of vegetables were consumed by the inhabitants, though the number of men with experience in their cultivation was limited. In order to increase the production several difficulties had to be overcome. First, and most important, it was necessary to convince the landholders that vegetable-growing would pay, and that it was to their advantage to put their energies into this as much as into their date gardens. Secondly, labour was scarce;

Amarah was not a large place, and the roads, railways, and other works, created a ready market at higher rates than the landholders could afford. Thirdly, heavy irrigation was necessary, and water-lifts or pumps had to be provided in addition to those already in use. Fourthly, seed was required. Lastly, the time for sowing the cold weather crops was rapidly passing.

A meeting was immediately called of all the men having land in the neighbourhood, and they were told that a very large increase in the area under vegetables was required, and were assured that all vegetables produced would be bought, if delivered in good condition. Their objections and difficulties were listened to, and, where necessary, further considered on the land and, if possible, removed. They were also informed that Government would look with favour upon those who showed a large increase, while those who did nothing rendered themselves liable to punishment. As far as this threat was concerned no action was actually necessary, though one or two men had to be warned again later on, and one man in particular, who owned an oil engine and pump which he seldom used, was told that if a stated portion of his land was not under vegetables within a given time, his pump would be bought for a price named and sold to a man anxious to use it ; his land was then sown. Two or three other meetings were held at intervals, and care was taken to impress upon all that the matter was to their advantage as well as ours.

The agricultural work resolved itself into constant visits to the men in their fields, and in this I received very valuable assistance from Sergeant Wimshurst. Wimshurst was a student at Wye when war broke out, and enlisted in the 1/5th Buffs, was wounded at the battle of Shaikh Saad, and later employed at the base where he learnt Arabic. He was transferred to me on November 15th 1916 and shortly afterwards promoted to sergeant. Towards the end of 1917 he was granted a commission at my request, and became an agricultural circle officer under the new arrangement. I am glad to take this opportunity of recording his useful work. As he was in Austria in 1914, and only reached Holland on the morning of August 4th, it was unfortunate that the enemy could not be informed

of the potential Turk-killing power (by means of men saved from scurvy) that had slipped through their fingers.

Advice and help was given to the growers, principally with the object of obtaining better results from their existing means, increasing these, and insuring as far as possible a succession of crops. Little help could be afforded in labour difficulties. In this, and similar cases, we could only say (if I may put it so) that, had the campaign been waged in order to provide the force with vegetables it would have been easy to supply them, but the issue of vegetables was only a small, though momentarily an unduly important item in the business of enabling the campaign to be waged. Comparatively little seed was distributed; the growers were suspicious of Indian seed and preferred their own, which dribbled down from the north. How it came I do not know, nor did I enquire too carefully, lest I should draw undue attention to the fact (the blockade was not my business, and the seed was coming in, not going out), but when it was wanted it usually came. An imported oil engine and pump which were available at Basrah, were sold to one of the most enterprising of the cultivators and several *noiria* pumps were disposed of in the same way. Wood, which it was almost impossible for the Arabs to procure, was supplied for *chered* rollers and *noiria* gears. A small two-acre garden was started as an object lesson in good clean cultivation. All this caused a substantial increase in the outturn, which would have been larger had we been able to start earlier in the season, and had the XIII Division not occupied the greater part of the lift-irrigated land on the left bank above the town.

Besides Amarah, similar measures were taken at Ali-al-Gharbi, Mudelil, Qalat Salih and Qurnah. Ali-al-Gharbi, $79\frac{1}{2}$ miles by river above Amarah, and 42 miles below Shaikh Saad, received particular attention and a pump, as it was the most northerly village where Arab cultivation could be used. The total out-turn was much less than at Amarah, as the inhabitants were few, but the proportional increase was greater. Mudelil and Qalat Salih produced enough for their garrisons. Qurnah made a good return, and, when the Qurnah-Amarah railway was opened, sent vegetables to Amarah, which were issued locally and released others for the front.

The following table gives the weight, in pounds, of the fresh vegetables purchased for the troops.

	Previous monthly average	Dec. 1916	Jany. 1917	Feb. 1917
Bought in Amarah ...	210,755 (1)	613,101	490,488	728,335
Out-turn from Amarah Garden ..	Nil	Nil	9,357	7,850
To Amarah from Qurnah ..	Nil	Nil	6,866	173,012
Bought in Ali-al-Gharbi ...	48,388 (2)	120,377	95,804	149,641
Total ...	259,143	733,478	602,515	1,058,838

(1) Average for 6 months April-September 1916 } There were no records of
(2) Average for 3 months August-October 1916 } previous purchases, if any.

It would be interesting to compare these figures with the returns for the cold weather 1915-16, but there were few vegetables and no records then; on the other hand, the out-turn per acre is, on the whole, larger from hot weather than from winter vegetables.

In addition to the work with the Arabs, various attempts were made to encourage direct cultivation by units at all places on the line of communication. The results, however, were small, nor is this to be wondered at under the existing conditions. The marching posts, at intervals of ten miles, were kept busy mounting guard and escorting, and the personnel, both at these and the larger places, was constantly changing. The best results were obtained at some of the hospitals. The first thing done at Shaikh Saad was to get boxes of cabbage seedlings sown by the seven *malis*, to be transplanted into land which two hospitals prepared. At Amarah at least three hospitals had already laid down good vegetable gardens, and arranged for their own seed, others followed their example. By one means or another, a fair amount was produced by direct cultivation, though much seed was unavoidably wasted. Unfortunately I have no definite records of the results, those that I have show that seed was distributed to seventeen hospitals, posts or units,—and there were certainly others.

Collecting.

Formerly vegetables had been purchased through a contractor, and very little enquiry proved that (like most contractors) he made large profits. But it will be remembered that my first proposals demanded prompt payment in cash and the abolition of contractors as an essential part of the scheme ; and this was arranged for by what became generally known as the Amarah market.

For this a convenient site was selected in the corner of a yard surrounded by a wall and situated near the river bank, where two open sheds, 84 feet long by 16 feet wide, were erected on an existing earthen plinth, and roughly floored with country bricks. There was no particular reason for these dimensions, except that they suited the available space and material ; all that was required was protection from the sun and rain.

The idea was very simple. Previously about 3,000 lb. of fresh vegetables had been sold daily in the bazaar to the inhabitants, and the remainder bought by the contractor and delivered to the S. & T. It was now made a penal offence for anyone who brought vegetables into the town to take them anywhere except into the market, and the police were instructed accordingly. Here they were examined, weighed, and bought at varying prices fixed at monthly intervals. What we did not require, or not less than 2,000 lb. a day, were taken out again and sold in the bazaar to the general public.

It was hoped that the market would have been ready by the end of November, but owing to various delays, lack of labour, scarcity of material (one shed fell in directly the roof was put on: wood had to be imported, so those responsible cut down the factor of safety as much as possible,—and sometimes overdid it), it was not completed until the middle of January, and opened on the 21st of that month. Sub-conductor Costello S. & T. was in charge, with a sergeant and pay clerk under him, and ran it well.

There was one item of the market's furniture that deserves a paragraph to itself: the cash-register. From hazy recollections of London shops, it seemed that a cash-register used backwards, would be some check on the payments. That is, the clerk would start the

day with a fixed sum in the drawer, and on payment being made, the register would be put through all its tricks, ring a bell, hoist the figures, and jot them down on paper, but the money would be taken out, not put in. Accordingly one was ordered. Unfortunately it arrived after I had left for Baghdad, and I never saw it. I believe the clerk was afraid of it, and it was only used a few times. However, I feel certain that it was the first cash-register in Mesopotamia.

The advantages of the market were obvious. The large profits previously made by the contractor were divided between the government and the growers, to the advantage of both. The vegetables sold in the town were the worst, not the best, as had been the case when the contractor received a fixed price for all. The growers were more careful to bring their produce in rapidly, as damaged goods were paid for at reduced rates. There was little extra expense; the number of coolies employed in packing, weighing and shipping, was proportionately the same as that necessary to handle the vegetables when delivered by the contractor, and a sergeant had always superintended this, thus the only permanent extra was the pay of the sub-conductor and the clerk.

The actual figures are as follows :—

Cost of erecting the market, Rs. 4,793-8-0. This was very high, and was due to the excessive cost of the imported material and the inflated wages of labour.

The amount bought from the contractor during the 20 days, January 1st to 20th, was 220,135 lb. The amount bought in the market during the 11 days, January 21st to 31st, was 270,353 lb. That is, an average increase of 13,570 lb. a day.

Had these 270,353 lb. been bought through the contractor they would have cost Rs. 16,897-1-0; but they actually cost Rs. 10,335-8-0, a saving of Rs. 6,561-9-0. The market, therefore, produced more vegetables at less cost, and more than paid for itself in the first eleven days.

TRANSPORTING.

The transport of fresh vegetables from Amarah to the front had not been very successful. They were sent up on a barge which left

twice a week and usually stopped to deliver rations at the posts *en route*. This, in addition to a slow journey, necessitated the contractor and the authorities saving all surplus on the intermediate days, for shipment on the day on which the barge left. The vegetables were packed in sacks or open baskets piled one on the other, and the loss from crushing and delay was very great. An open barge with shelves was first selected, so that the vegetables were not heaped up in one mass, but this was not sufficient. Reports showed that there was still over 50 per cent. loss in transit.

The best course in the circumstances would have been to organize a special service of fast steamers, so that one left each evening carrying the vegetables received that day, properly packed in crates. This, however, was never attained, the real reason being that boats could not be spared. Nevertheless, considerable improvement was effected. Crates were procured from India in planks, nailed together locally, packed in the market and as many of them as possible placed on passing steamers, almost all of which stopped at Amarah. Similar measures were taken at Ali-al-Gharbi. By these means the amount of loss in transit was considerably reduced, though it remained an ever present trouble.

What proportion of the requirements was the 1,058,330 lb. produced in February ? At the end of January the ration strength of the force at Amarah and above was 50,738 British and 90,389 Indians, and the weight of vegetables required during February was, therefore, 2,058,330 lb. of which we were producing over half. In addition there were the vegetables produced by direct cultivation, and those supplied in Mudelil, which are not included. But, as explained above, there was considerable loss in transit, so that, while the XIII Division and the troops on the line received full rations, the men at the front got less than half, and those furthest away less still. Had the position remained unaltered, there would have been a further improvement during the next season, operations could have been commenced in time ; a Sheik near Ali-al-Gharbi was about to put down a large area ; a Jew was found, who was willing to arrange another large section near Kumait ; pumps capable of irrigating several hundred acres had been ordered for a Sheik near

Amarah. But all these, and other plans, were abandoned on the advance.

II. During the advance.

Everyone knows the chief features of the advance from the Sannayat-Sinn position to Baghdad, and beyond. The steady fighting up the right bank during part of December and January, the Shumraon crossing, the retreat of the Turks, and the entry into Baghdad on March 11th 1917.

An anxious time, probably, for many people, besides the Turks certainly for the agricultural section. That which one hoped for, yet in one way dreaded, had occurred; the troops were running away from their vegetables, which could not be picked up and carried along behind. The only thing to do was to follow the army up anxiously scanning the banks for likely places for farms, and feverishly cross-examining Arabs as to where vegetables could be obtained. All the replies pointed to Baghdad as the only hope. It all came right in the end—but what if the army had not reached Baghdad?

III. Baghdad and beyond.

Arrived in Baghdad, the first essential was to estimate the vegetables in the neighbourhood; a difficult thing to do with any exactitude. Cultivation of all sorts had decreased during the last two years, and, at the moment, numbers of cultivators had cleared off, through a not unnatural desire to get out of the way of the war. There seemed, however, to be more vegetables on the ground than we had left behind in Amarah—which was so far to the good.

It may be thought that our difficulties had settled themselves; but they had not. In the first place, the quantities grown at Amarah were not enough, as has been shown. In the second place, Amarah was a small town and the requirements of the population comparatively negligible; but Baghdad, on the other hand, was a large town, the inhabitants of which were used to cultivated vegetables and consumed considerable amounts. Again, owing to the needs of the army, and the dislocation of many of the

ordinary channels of supply, certain of their usual sources of food were reduced or almost entirely cut off, while prices rose at once; so that the people were driven more and more to depend on locally grown vegetable food. In fact the scarcity became so great that the military organization had to import grain for the civil population; an additional strain on the long and severely taxed line of communication already burdened with the supply of the force. But that is another story. From our point of view reliable estimates of the vegetables available were at all times almost impossible to compute, for, not only had the constant movements of the troops to be considered, but allowance made for a varying and unknown factor, the requirements of the town.

There were, then, not enough vegetables to supply both the troops and the town, and it was necessary to start again on much the same lines as at Amarah, telling the people that large quantities would be required, and helping them to get those quantities grown. For the moment, however, no one knew who were the owners of much of the land, or where they lived—though the authorities were rapidly finding out. As an immediate step Sir Percy Cox kindly circularized his Political Officers and some of the well-known landholders near. Gradually in one way or another the men were told. and the effort started. Our strongest card was to point to the money made by the cultivators at Amarah, a fact now for the first time plain to the inhabitants of Baghdad. The most cursory enquiry at once brought up the question of the pumps, a difficulty that was always with us. I have said that there were a few oil engines and pumps at Amarah, but, the number being small, it was an easy matter to supply them with oil. At Baghdad, however, there were hundreds dotted along the river banks. In a few months we had over 270 on our list, the majority within five miles above or below the town. The owners of these engines had had increasing difficulty in procuring oil since Turkey joined the war; the price, formerly from one and a half to two rupees a tin, had risen to a Turkish pound. After our occupation there was none, and, unless it were supplied almost at once, crops which were irrigated by the pumps would die. Some of them did die, and others were severely

checked; but luckily the general total slowly rose owing to an increase in the number of *chereds*, and extra sowings by men we supplied with oil.

This sudden demand for oil caused much anxiety. It could be obtained from the Anglo-Persian oil fields below Basrah, but had to be brought up the line, which was already overworked, and its transport would take time. Various temporary measures were adopted. A little was captured in Baghdad, of which I obtained 500 gallons for the pumps. I begged 548 gallons from the Camp Commandant at G. H. Q. I was given 2,000 gallons from the ordinary S. & T. supplies. Then we began to receive larger quantities from the oil *mahalas* coming up the river. But by April 25th only 9,064 gallons had been distributed, as against my estimate of forty to fifty thousand gallons a month required. No wonder the crops were looking bad. It was nobody's fault, of course; even the most exacting would hardly expect an army, at the end of a sudden and rapid advance, to produce on demand large quantities of oil that no one knew would be required.

It was not enough, however, to bring the oil to Baghdad, it had to be distributed to the cultivators. The first 500 gallons were given to a few men present at the time, who I knew had pumps and crops. The next 2,252 gallons were carted to a godown lent by the First Revenue Officer, and distributed, with the help of my interpreter and a small Arab youth who proudly answered to the name of clerk, to men already on our list. The confusion was immense, crowds clamoured round the godown hearing that oil was for sale. Things could not go on like that, but, luckily, as I was endeavouring to get a proper staff, Mr. Wilson of Strick Scott's firm arrived. He had been in Baghdad before the war, and, among other things, had dealt in oil. An agreement was made with him whereby he received and distributed the oil, kept the books and collected the cash, receiving as commission ten per cent. of its cost price to Government. It was only issued to men on our list, and on an order countersigned by the Director of Supply and Transport or myself. This arrangement worked very well until after the period covered by this report, when, with the increase of the

department and the extra men employed, it was possible to make other plans.

Before Mr. Wilson's advent, and even afterwards for a time, I was harassed by crowds of Arabs—varying from the sullen and indignant, through the dignified and grave, to the pathetic and almost tearful—all clamouring for oil. They followed me about, and invaded my room at all hours of the day, and sometimes sat outside at night. For the most part they were quite reasonable, and realized we were doing the best we could. Gradually the lists were completed, and the proportion due to each adjudged.

But our troubles were not over. Even had we had the most perfect methods of distribution we must have had trouble as the amount available did not meet the demand. In April the authorities agreed to supply fifty thousand gallons a month, the quantity then estimated to be enough. By August the requirements had increased, owing to the hot weather, the greater quantity of pumps in use and of land under crops, and the estimate had to be raised to eighty thousand gallons a month. But, far from increasing our supplies, the original fifty thousand gallons could not be delivered. Some actual figures are :—for July, 36,868 gallons; for August, 54,572 gallons; for September, 34,448 gallons. It was obvious that crops were suffering, and discontented cultivators once more appeared. The river was low, oil barges few, and difficult to get up, while extra supplies were wanted, to light the town, work ice plants, for sanitary use. Special efforts were made to accelerate delivery; while soon, owing first to the cooler weather, later to the rain, less irrigation was required and less oil was in demand.

An interesting sidelight was the small amount of water actually necessary to keep a plant alive. I wish I had been able to get figures of water supplied and crops produced—they would, I think, have startled irrigation experts here.

In addition to procuring burning and lubricating oil, it was necessary to provide repairs. Shortly after we arrived, the First Revenue Officer found six men for me who had worked in repairing shops before the war, and an attempt was made to make use of them. It proved impossible to work them as a controlled concern,

spares were difficult to get, and materials were not available for a shop. Again a stroke of luck! An old Arab, an excellent "mistri," was found, who, with a little semi-official help, carried out the work himself. He bought (and, possibly, found) spare parts from those who had them, or whose engines had been broken by the Turks, and collected his own break-down gang. Passes were given to him and his men to enter and leave the town, and belts and spares occasionally bought for him from Works. All the same, clever though he was, he could not manage serious repairs, and his resources steadily became less; so suggestions were made that the repairing work should be undertaken by Works, and in September 1917, a letter was put up to the D. S. and T. making definite proposals. Eventually Works took over the whole, but after the period of these notes.

Most of the pumps were near Baghdad, but there were a few at other places in the forward area and dotted down the line. These received oil from the nearest supply depôt on instructions from headquarters, and the number dealt with thus increased as the country became more settled.

At first our principal agricultural work was in the neighbourhood of Baghdad, but a considerable amount was done at other centres, such as near Baqubah, Fallujah, Samarrah and Ramadie in the forward area, and at or near almost every station down the line. The methods adopted were much the same as those already described at Amarah, and our object was to get the Arabs to grow the requirements themselves.

Sergeant Wimshurst came to Baghdad in May; and Lieutenant Cheesman ably superintended the work on the lower L. of C. after the Madras garden corps arrived and relieved him of the Shaikh Saad farm.

A particularly neat arrangement was carried out with the help of the VII Division at Samarrah, whereby cultivation was encouraged in their area, and even beyond our lines, in spite of the presence of two hostile armies. Major MacMahon, their D. A. A. and Q. M. G., took a lot of trouble over this. The XV Division, with Lieutenant Cheesman's advice, did much to encourage production at Nasiriyah,

and later at Ramadie. In fact, once the methods were explained, the work was taken up on all sides.

The most unfortunate place, and the one most difficult to supply during the hot weather, was Basrah. Efforts to increase the cultivation of vegetables in that neighbourhood did not meet with much success, owing to labour difficulties and probably to lack o expert advice. It should have been possible to make up their deficiencies with vegetables from Amarah and Qurnah but, with the transfer of Sergeant Wimshurst and myself to Baghdad, the purchases in these places fell off considerably (February, 901,347 lb.; March, 658,280 lb.; April, 332,920 lb.; May, 504,000 lb.), while proper arrangements, apparently, were not made for sending the supplies down stream. Later, however, I transferred Lieutenant Cheesman to Amarah to reorganize the supply.

Gardens run by the troops themselves seldom reduced the ration demands, principally because a unit rarely remained in one place for a sufficient length of time; but three gardens in particular gave good results, at Nasiriyah, Fallujah and Ahwaz, while small amounts were produced at Diyalah, Ctesiphon, Baghailah, Aziziyah and elsewhere. Vegetable seed was given to all units on demand until September 1917; but then free seed was no longer necessarily supplied to units in places where sufficient vegetables were known to exist. The following amounts, in pounds, were issued (the figures in brackets are the weights received from India):—Beans, broad 1,547 (5); beans, French 71 (60); beans, haricot 1 (5); beans, kidney 814 (0); beetroot 473 (379); brinjal 345 (57); cabbage 112 (295); carrot 249 (113); cauliflower 33 (114); chillie 38 (23); cucumber 1,333 (152); gourd 407 (414); kohl rabi 34 (38); lady's fingers 1,305 (604); lettuce 61 (21); melon, rock 18 (18); melon, sugar 275 (0); melon, water 878 (30); onion 1,063 (95); peas 52 (59); pumpkin 112 (57); radish 601 (6); spinach 773 (314); tomato 120 (25); turnip 407 (133).

The above are the majority of the seeds distributed direct, and were supplied to units, Arabs (most of whom, however, found it cheaper to procure their own), and our own farms at Shaikh Saad and Baghdad.

The seed sent from India had a long and difficult journey, and the germination of a few of the samples that arrived was *nil*.

As against this, however, it became more and more easy to obtain seed in the country (some of the varieties were called Damascus and some Stamboul—whether or not they really came from there I do not know); and, on the whole, the country varieties did better than the Indian.

The Shaikh Saad farm, as recorded above, was fifty acres, taken up immediately after I came out. When I first left there for Amarah, Lieutenant Cheesman, I.A.R. (formerly of Wye, and then 1/5th Buffs), was detailed as my assistant and went to Shaikh Saad to organize the farm, arriving there on October 26th 1916. He had many difficulties to contend with, due to scarcity of labour; but gradually implements, a pump and a small staff (an Indian officer, 3 British privates, about 30 Indians and 24 bullocks) were collected, and at the end of the year I was able to send him Sergeant Aldridge, an excellent practical gardener, also of the 1/5th Buffs (the agricultural section might almost be described as an offshoot of the Buffs—proving the prowess of the men of Kent in agriculture, in addition to other directions!). Much spade work had to be done before the farm began to produce; its first returns were 402 lb. in March and 3,980 lb. in April 1917. The difficulties were reduced when the Madras garden corps arrived in May.

This corps, if I remember rightly, was first offered by Madras in November 1916. Under the then conditions, I suggested that enough men be asked for for the Shaikh Saad farm and a similar farm at Arab Village or elsewhere; and a telegram to that effect was sent. The personnel eventually despatched was 2 British officers, 2 British N. C. O.s, 1 sub-assistant surgeon, 1 clerk, 4 head *malis*, 24 *malis*, 220 coolies, 3 *bhisties* and 3 sweepers. Unfortunately they were only enlisted for a year, and did not arrive until May 1917, when the conditions had entirely changed. I placed about half at Shaikh Saad, and the remainder on a farm at Baghdad. They produced good crops while they were out, but left in February 1918 on the completion of their year. The figures of the cost of the vegetables they produced proved the wisdom, even from economy alone, of

confining our efforts, wherever possible, to production by the Arabs. For example, the cost of the vegetables produced on the Baghdad farm, from the time of the arrival of the corps on May 24th, to the end of September (excluding the cost of rations, tents, clothing, implements, seed, et cetera, and 3½ months' pay while coming out) was 2·3 annas, as against the contractor's price of 0·88 anna a pound.

Fruit, with the exception of melons, was beyond the powers of the agricultural section. There were fruit trees (oranges, limes, mulberries, apricots, figs, pomegranates, each in their season, in larger or smaller quantities) at Baqubah, Båghdad and elsewhere; but it was useless to try to increase the immediate supply, and improvements in pruning and so forth could only have been introduced slowly by a large staff. It was possible, however, to increase the area under melons, and this was done. The ration was 2 oz. daily of fruit, either fresh or tinned.

Notwithstanding the success of the Amarah market, the new purchasing department was averse to starting similar concerns elsewhere—at Baghdad, I believe, because of the size of the undertaking, and at other centres, because the position had become easier, and contracts were preferred.

Transport difficulties were considerably reduced. The troops were spread out, instead of concentrated in one spot; while railways from Baghdad to Samarrah, Baqubah and Fallujah, combined with motor transport, rendered the distribution comparatively easy, especially as each centre became more nearly self-supporting.

Results.

The following table gives the quantities in pounds purchased and supplied from the larger farms:—

Month 1917	Line of communication	Forward area	Shaikh Saad farm	Baghdad farm	Total
April	640,920	713,720	3,980	nil	1,358,620
May	909,440	892,080	7,963	nil	1,809,483
June	1,624,840	1,514,240	25,065	nil	3,164,145
July	1,916,520	2,054,640	46,773	1,829	4,019,762
August ...	1,958,600	2,173,640	47,000	61,893	4,241,133
September ..	1,942,080	2,705,360	57,647	79,391	4,784,478
October ..	1,826,160	2,551,640	50,219	76,536	4,504,555
November	1,294,440	2,174,200	79,960	23,135	3,571,735
December	2,336,575	2,556,794	149,769	27,139	5,070,267

The rise in the above returns for June may fairly be taken as proof of the efficacy of the work in and around Baghdad and on the upper L. of C., from the time of the capture of the town. The contractors began to deliver our full requirements in Baghdad from about May 25th.

The following table shows the relation between the vegetables supplied, and the amounts required for the daily ration of 12 oz. for British and 6 oz. for Indian ranks :—

Approximate ration strength on (1)	British	Indian	Weight required during the month, pounds	Weight supplied, pounds	Excess (+) deficit (−) pounds
September 1st ...	88,965	238,405	4,683,768	4,784,478	+100,710
October 1st ...	101,305	265,562	5,442,499	4,504,555	937,944
November 1st ...	107,785	278,420	5,557,387	3,571,735	−1,985,652
December 1st ...	121,773	315,128	6,494,585	5,070,267	−1,424,318

(1) The ration strength is the whole Expeditionary Force, including Medical, I. W. T. Labour corps, followers, et cetera.

Under conditions such as described, a renewed shortage was almost inevitable when the force was increased (in terms of vegetables required), by nearly 40 per cent.; but the supply was gaining again on the demand by December, and the shortage was never as bad as it seemed, for two reasons. Firstly, when massing the figures in this way, no account can be taken of those troops who, owing to operations, movements, and so forth, could not be supplied temporarily; but their numbers were sometimes large. Secondly, the potatoes and onions imported from India are not included. I have not got any figures here, except those showing that in December 785,557 lb. of potatoes and onions (more than half the deficit) were issued on the lower L. of C. alone, from Basrah to Kut inclusive.

There was another amusing proof that the vegetable position was practically secure. In the early days the average man was delighted if he received a somewhat damaged turnip, or even wilted turnip tops. Towards the end of the time complaints began to be heard. "We do not want lady's fingers, we do not like them, and we are tired of brinjals too," said the army, in effect, "why not give us cauliflowers or cabbages or peas?" Or later, in the cold

weather, " nothing but turnips "— or beetroot, or lettuce, as the case may be. It was little use explaining that cauliflowers or peas could not be grown in the hot weather, or that it was necessary to concentrate on the higher yielders among the vegetables known to the Arab,—they simply did not believe you. And personally I sympathized, I never liked hot weather vegetables myself.

The ultimate test for the results, however, must be sought in the scurvy returns, as the principal reason of the ration was its antiscorbutic effect. This is shown in the table below which compares the numbers of scurvy cases admitted into hospital for the whole force during the hottest months of 1916 and 1917.

Month	Number of cases 1916	Number of cases 1917
July ...	2,465	339
August ...	3,395	211
September ...	2,990	168

During this time the ration strength had approximately doubled, the proportion of admissions, therefore, had fallen by over 95 per cent. A proof that the vegetable ration was the chief, though not the only, means for combating the disease, is that 46 per cent. of the remaining cases occurred in Basrah, the place most undersupplied.

SOME FACTORS WHICH INFLUENCE THE YIELD OF PADDY IN COMPARATIVE MANURIAL EXPERIMENTS AT THE MANGANALLUR AGRICULTURAL STATION.*

BY

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THE Manganallur Agricultural Station is situated in the Tanjore delta, and is devoted to the study of wet land or swamp paddy. This crop is grown in fields enclosed by earth "bunds" or ridges to hold in the irrigation water, and the fields are each about one acre in extent. The soil is a heavy clay, such as one would expect from deposition of fine silt in standing water. Analyses show that 65 per cent. of the soil consists of clay and fine silt.

The following outlines the method of cultivating the crop. The sprouted seed is sown in a manured seed-bed, which is prepared by ploughing under water (puddling) and carefully levelling with a board. Shallow drainage channels are made at intervals across the seed-bed to drain off superfluous water. When the seedlings are about 40 days old, they are pulled out and carried to the field which has been prepared by puddling and levelling, and here they are singly planted out at intervals of about 9 inches. In a few days these strike fresh root, and subsequent operations consist of weeding

* This article was originally intended for the Madras Year Book, but the writer felt that this question of the study of field experiments, not only in the case of manurial experiments with paddy, but with practically all field experiments, was of such importance that it might gain wider publicity in the *Agricultural Journal of India*, and that other workers might reciprocate in giving their experience of similar observations in the case of other crop experiments in India. [H. C. S.]

once, or twice if necessary, and regulating the supply of irrigation water which is maintained at a depth of 3-4 inches. Irrigation continues until about two weeks before harvest, when the water is drained out and the field is allowed to dry.

Manurial experiments are of two types. Those which are designed to test the effect of a manure on the succeeding crop *i.e.*, a single application of manure, the results of which are recorded in the yields obtained, and the experiment is concluded. In the other type, the same manure is annually applied to the same plot to ascertain the cumulative effect of the manure. In this latter case one has not only to compare the yields obtained in the one year but also to compare the yields obtained in one year with those obtained in another.

If such experiments were absolutely under control, then the results obtained from duplicate or multiple plots under the same treatment should always agree in any one season, and it is these factors which cause variation in yield between plots receiving the same treatment and which are now under discussion.

The first type of experiments, namely, those concluded in one season, is likely to give much more accurate results, but they give much more meagre information, and their scope is strictly limited. Many more factors in this case are under control.

The seed used in the seed-bed is the same. If the seed-bed is properly prepared, and if seedlings along the margin and the drains are not used, it is possible to get seedlings all of the same age and quality. The planting of all the plots can be completed in the same day. Irrigation and surface drainage are the same. It will, however, be found that no two plots under the same treatment will ever give the same yield, and if the experiment were repeated the following year on the same field, it would be found that the results obtained would be different from those obtained in the previous year. These differences in yield are due to factors which are beyond control.

In the first place, it is impossible to get land of even fertility, and this is more difficult probably in the case of swamp paddy than with any other crop. When the land is ploughed under water, a

great proportion of the debris of the previous crop floats to the surface, and the wind will blow this to one side of the field. If there are regular prevailing winds, then the side of the field opposite the direction of this wind is always more fertile. In this case the south-west monsoon winds are blowing when the fields are ploughed, and the north-east side or corner of the field is always the most fertile. Such crop debris is also apt to clog on the plough, and where this drops off or is removed, the soil is enriched at that spot. In levelling the field the surface soil is drawn from the higher to the lower levels of the field, and, when level, such portions which were originally lower are inclined to be more fertile. The texture of the soil is also affected by irrigation. Around the water inlet, where the flow of water into the field is rapid, much more coarse soil particles are deposited, while the farther away from the inlet, the less will be the flow and the finer will be the sediment deposited. Thus, even though care has been taken to standardize the field by harvesting the previous crops in small areas, a further error is always liable to creep in from the ordinary cultivation operations in the field.

Weeds again are another source of error. If the field is not uniformly levelled, and the water is not kept to a sufficient depth in the field, rushes, sedges and other semi-aquatic weeds are bound to spring up wherever the soil is exposed. The debris blown to the side of the field also contains large numbers of weed seeds and *Marsilia coromandaliana* may be mentioned as one which is often troublesome. "Veppam pasai" (Tam.) [*Chara*, spp.] is also a very troublesome aquatic weed which may greatly check the growth of the paddy. This is much more likely to affect the unmanured or check plots, because these are always backward in becoming established, and this weed which requires full sunlight will often get a hold here, while on the manured plot it may be suppressed. When once it has got a firm hold it is very difficult to eradicate, and as it keeps the growth of the crop in check, it will materially lessen the yield. Thus the difference in the yield of the manured and the unmanured plot may be much greater on this account than if this weed were not present. It may be said that such difference should

be credited to the manure. In ordinary farming it can be, but in an experiment it must be discounted, because there is no guarantee that every field has this weed present.

The season also may affect the yield of different plots. Heavy rains in the fallow period will cause these lands, which, when dry have cracked both widely and deeply, to swell and more or less completely close these cracks. This is disastrous to the succeeding crop as it stops drainage and soil water movement through the soil not only this, but the soil below the surface becomes so compact that the roots of the crop are unable to use any but the surface soil The efficiency of the cultivation is greatly decreased and only a shallow puddle can be procured. These delta soils though very uniform near the surface vary very considerably in depth. Those on this Agricultural Station rest on coarse river sand which may be a few feet or many yards from the surface. It is obvious therefore that the deeper the clay alluvium, the more disastrous are the effects of this check in drainage. In this way even parts of the same field may be affected differently. The same result occurs when irrigation water is let into the field and the field is then allowed to dry. If the water is kept continuously on the field then the drainage is not adversely affected.

The season may also affect the development of the grain. It has already been pointed out that the manured crop will often become established more quickly than the unmanured fields, and these naturally come into ear sooner. For example, a crop manured with superphosphate will invariably come into ear a few days sooner than a crop which is unmanured. A heavy rain at the flowering time will affect the setting of the grain, and one plot may suffer while the other escapes. In the same way a rain at harvest time may cause one of the crops to shed more than the other.

The question of the crop being laid may affect the yield. The straw of these delta paddies is invariably weak, and a manured crop, especially if manured with nitrogenous manures, may be badly laid, sometimes even before it has come into ear. Unmanured plots on the other hand will often remain standing until cut. If a crop is laid before the water is drained off the field, some of the

grain invariably gets damaged. Even if it is laid after the water is drained and the weather is dry, much more grain is shed during the operation of harvesting than is the case with a standing crop.

To ensure the greatest accuracy, therefore, it is necessary not only to multiply the number of plots receiving the same treatment and take the average results, but it is also necessary to repeat the experiment for several seasons and take the average of these. This, however, would involve a very large area of land, as it is obvious that a fresh area would have to be selected each year for each experiment on account of the manurial residue left in the soil.

The majority of manurial experiments, however, deal with the cumulative effect of manures when annually applied to the same plot. The type of experiment already discussed, deals only with the effect of quick-acting or soluble manures which show their results on the succeeding crop, and the causes which affect the yield of continuous experiments on the same land, besides including all and accentuating many of those already discussed, introduce many new factors which affect the yield. During the same season the control is just the same, but comparing the yields from season to season, only three factors can be definitely controlled, *viz.*, the shape and area of the plots, the quantity of manure applied, and the actual weighments of grain yield. Straw yields cannot be controlled, as the moisture content varies with the ripeness of the straw and the state of the weather. The seed may be of the same variety, but it may be of different quality, *i.e.*, germinative energy and capacity. The seedlings may be of different quality and age. The season may be early or late. If it is late, the effect of the manure, especially phosphatic manure, will be more marked, because late planting always affects the yield, and the crop becomes established sooner and matures sooner when manured with phosphates. The physical soil conditions, however, vary very much from season to season, and if the drainage is bad and the puddle shallow, very little effect of manurial treatment will be seen.

In the case of many manures, especially bulky organic manures, these in themselves greatly alter the texture of the soil, and the cumulative effect in this respect is often very marked and apparently

very variable. The effect of other manures applied in conjunction with such organic manures also varies greatly. For example, where an organic manure has been able to improve the texture of the soil, so that the season effects of poor physical drainage are counteracted—this may occur if the alluvium is not too thick—then other manures applied in conjunction with the organic manure may show marked increase in yield. If, however, the alluvium is deep and only the texture of the surface has been improved, a bulky organic manure is, under these anaerobic conditions of cultivation, liable to turn the soil acid. An acid manure, such as superphosphate, would in this case very probably do more harm than good in that particular plot, while the organic manure itself might also show a decrease in yield when compared with the check plots. The residual value of the manure in the duplicate plots would, however, be very different, and if in the next year the physical conditions of both plots are good, the yields will vary greatly.

It is thus evident that if plots are merely duplicated, it is impossible always to draw conclusions merely by studying the figures of yield. One plot may show an increase, while its duplicate may show a decrease. The continuance of the experiment over a number of years will give an average, but it must be remembered that the cumulative effect of the manure has also to be taken into account. The solution of the difficulty seems therefore to be in multiplying the number of plots under the same treatment and averaging the results.

Another factor which seems to be an insoluble difficulty in such permanent experiments is the formation of the plot or unit of experiment. There are two methods of doing this. Firstly, each plot may be separated from the next by a permanent earth bund or ridge; and, secondly, each plot can be marked by permanent stones and separated from the next plot by an unmanured strip. Neither of these ways is perfect. The objections to the former are :—
(1) It is difficult to get uniform cultivation and levelling. (2) Each plot has to be irrigated and drained separately. (3) The margins of the plot will invariably show better growth. (4) The crop is much more exposed to attack of crabs and caterpillars which the

permanent earth bunds will harbour. (5) Unless these bunds are high, they are very liable to break down during the cultivation season and not hold the water in the field. They are often submerged during heavy rains. If the bunds are high, the crop is not under normal conditions, as it is too much protected from the wind, and the soil from the bunds is continually being washed down into the field from which it has again to be lifted in the next season when the bunds are repaired. High bunds also leak very badly, as they harbour crabs and rats which riddle these with their tunnels.

The latter method is preferable on the whole because, (1) observation shows that soils, even under these swamp conditions of cultivation, receive and retain manures as soon as they are applied. Nitrates are an exception, but these do not come within the scope of manurial experiments with wet-land paddy. There is therefore little, if anything, to be gained in this respect by providing earth bunds. (2) It is possible to puddle each plot as a separate unit, but unfortunately it is not possible to level each plot separately, as the whole field has to be of the same level; there is therefore always a certain amount of mixing of the surface soil in the plot with the surface soil adjacent to it, and the residual value of previous applications does not entirely remain in the plot to which the manure was originally applied. Observation shows that this effect is apparent in the growing crop to a distance of 5 to 6 feet from the margin of the plot. It is necessary therefore to leave a non-experimental strip of at least this width between plots. (3) As regards irrigation, drainage, weeding, etc., conditions are uniform for all plots; while the danger of loss from the insect and other pests is minimized.

What has been written indicates the importance of maintaining careful observation notes of experiments and the danger that lies in merely judging the results of different plots by the figures of yields recorded. There are so many factors which induce error, and which are beyond control, that without such observation it is often impossible to draw any deductions of value from the yield figures recorded. Much has been written about the importance of estimating the probable error of an experiment. In any experiment concluded in one season this must form the basis of the value of the

results obtained; but in a continuous experiment conducted over several years on the same plots, there are so many factors which alter the original condition of the plots and so many factors which vary from season to season that, after the first year, the only method of gauging the value of the yields obtained is by the study of the growing crop in the field.

EXPERIMENTAL ERROR IN VARIETY TESTS WITH RICE.

BY

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INTRODUCTION.

ALL work on the improvement of crops, whether by the introduction of new varieties or by plant-breeding, requires constant comparisons to be made with regard to yield. Where large numbers of strains are being grown for comparison any increase in the accuracy or rapidity with which undesirables can be rejected results in a correspondingly increased efficiency in the work. A study of the experimental error involved in different methods of making these comparisons is, therefore, of the utmost importance, since the knowledge obtained makes it possible to handle, with any required accuracy, the maximum amount of material for a given set of conditions or resources.

During the last ten years, numerous investigators have drawn attention to the importance of experimental error in all types of agricultural experiments. This has had its effect in improving, very considerably, much of the work that is being done. There is still, however, room for improvement in a good deal of the work of which accounts are published.

It is not proposed to discuss the literature on this subject. Lists of references will be found in papers by Hayes and Arny[1] and Batchelor and Reed.[2] These include work on a large variety

[1] Hayes, H. K., and Arny, A. C., *Journ. Agric. Res.*, vol. XI (1917), no. 9, p. 399.
[2] Batchelor, L. D., and Reed, H. S. *Journ. Agric. Res.*, vol. XII (1918), no. 5, p. 245.

of crops, including fruit trees, under very varying conditions. The systems adopted by different workers, for reducing the experimental error to any required degree, vary very considerably according to the type of experiment, *e.g.*, whether manurial or variety tests, the quality and quantity of land available, the crop under experiment, etc.

It is proposed in this paper to refer briefly to experimental error in general, under Indian conditions, and to give, in some detail, the results of work on rice in Madras Presidency.

EXPERIMENTAL ERROR IN INDIA.

The experimental error of ordinary field-plots has been calculated by different workers for various types of cultivation in different countries. Although there is not as much variation as might be expected for the widely varying conditions involved, it would be impossible to apply any one figure to a given set of conditions without some preliminary investigation.

In order to get some idea of the range of error for various types of cultivation in different parts of India, an examination was made of the results of experiments given in the farm reports of different provinces. The *probable error* was worked out from the yields of duplicate plots as given in these reports. It was very common to find two distinct *series* of plots, of obviously different cropping value, described as *original* and *duplicate* respectively. Results from such separate series were carefully excluded. Apart from this, the figures employed were not in any way selected but were taken at random from any experiments that included a number of duplicates.

This is the same method as was employed by Wood and Stratton[1] in the case of results published in England. It should be noted, however, that the method of calculation employed by these authors (*l.c.*, pp. 436–7) is subject to a definite error. For each pair of plots they calculate the mean and the difference between each plot and the mean. These differences, after reducing to percentages of the mean, in order that the results of different experiments

[1] Wood, T. B., and Stratton, F. J. M. *Journ. Agric. Science*, vol. III (1910), p. 417.

may be combined, they then use for the probable error determination in the same way as they would use differences from the mean of a large number of determinations. In other words, they take differences between duplicates as twice the difference of one from the mean. Now the probable difference between any two results taken at random, such as duplicates, is $\sqrt{2}$ times the probable difference of any one from the mean. It is obvious that, in calculating the probable error from the results of duplicate plots, the difference between any pair should be taken as $\sqrt{2}$ times the difference of one from the mean. Their result for 400 pairs of plots, *viz.*, 4·2 per cent., should, therefore, be multiplied by $\sqrt{2}$, thus giving about 6 per cent. as the probable error for one plot, or 8·4 per cent. for the difference between two plots.

Except for this modification, the same "least square" method of calculating the probable error was applied. The results were worked out as the *probable error of the difference between two plots*, as it is such differences that most experiments are designed to show. As was to be expected, much variation was found when each set of experiments was taken separately. A critical examination of the figures, however, showed much about the same range of error for the different sizes of plots, about 4 to 25 cents, and for different localities. Table I shows the figures obtained for four of the most important crops, representing widely different types of cultivation.

TABLE I.

Probable error of ordinary field-plots in India.

Crop	No. of pairs	% Probable error between two
Rice	240	13·0
Sorghum	166	11·8
Cotton	114	12·2
Wheat	114	11·0
Combined result ...	634	13·5

The results for the different crops show surprisingly little variation. The combined figure, 13·5 per cent., for the probable

error of the difference between two plots, is not very satisfactory, being very much higher than the corrected figure of Wood and Stratton already referred to, *viz.*, 8·4 per cent. for ordinary experiments in England. It must be remembered that this figure is an average result, and there must be, as indeed the details show there are, many experiments with an error much higher than this.

Work on rice in Madras.

A detailed study of this subject has been made in connexion with work on rice in Madras. The probable error has been worked out for different sizes and shapes of plots varying from ordinary field-plots of over one-tenth of an acre down to lines of 20 plants.

Ordinary field-plots.

Under this heading are included such experimental plots, ordinarily in use on the farms, as have not been laid down in the form of specially long narrow strips. Table II gives details for a number of separate experiments on various farms.

Table II.

Probable error of ordinary field-plots of rice in Madras.

Farm	Experiment	No. of plots	% Probable error between two
Coimbatore ...	Standardization N Block	20 plots	13·0
" ...	Pattimannu manurials	21 pairs	13·4
" ...	Age of seedlings	8 "	13·6
Samalkota ...	Cyanamide manurials	20 plots	13·9
" ...	Spacing	22 pairs	7·7
Palur	Bulky manures	72 "	11·3
Manganallur ...	Phosphate manurials	20 "	12·6
"	Udu manurials	60 "	13·9
	Combined result	203 pairs 40 plots	12·3

The results are very uniform with the exception of one experiment, a spacing experiment at Samalkota, which, for some reason unknown, is very distinctly more accurate than the others. The

low figure for this experiment reduces the combined result to 12·3 per cent., though the other results suggest that about 13 per cent. would be more representative of ordinary conditions.

Long narrow field-plots.

Under this heading are included plots specially laid down in the form of long narrow strips with a view to reducing experimental error. They are large plots such as can be used for the majority of ordinary farm experiments, and are in quite a different category from the small strips, to be described later, for use only in variety trials. Table III gives data for a number of series of such plots.

TABLE III.

Probable error of long narrow field-plots.

Farm	Experiment	Area in cents	Dimensions	No of plots	% Probable error between two
Coimbatore ...	B. Standardization	About 10	Lengthmore than ten times breadth	18	6·0
Manganallur* ...	Fish	5		11	7·0
Do. * ...	Super	5		14	5·5
Do. * ...	Standardization	5	20 × 250 lks	28	8·7
Do. ...	Do.	·24	20 × 120 lks.	35	5·7

* For the figures on which these results are based I am indebted to Mr. Sampson.

It will be seen that the probable error of these plots is consistently lower than that of the ordinary plots, shown in Table II, by a considerable amount. It is obviously desirable that such plots should be adopted more generally where the nature of the experiment permits. A large departure from this type would very seldom be necessary.

Lines and small plots for variety-tests.

In working with transplanted rice it is comparatively easy to obtain a full stand of plants very evenly spaced. It was considered, therefore, that the method of testing strains by [illegible] lines or narrow strips would be particularly useful for this crop. Experiments designed to test this have been carried out during several years, and have yielded some interesting results.

The first experiment was carried out, during two successive years, on the ordinary experimental area of the Central Farm, Coimbatore. The method was to divide a field, planted uniformly with one variety, into a number of very small units of regular size and shape. These units were harvested separately and their grain stripped by hand and weighed. It was then possible, by various combinations of units, to compare the yields of small plots of various sizes and shapes.

In 1913-14 one field was used, and in 1914-15 the same field again together with a neighbouring field of about equal area. These fields were planted very evenly at 9 inches apart each way. In each case, after removing a number of lines round the outside, a block of plants was obtained comprising 80 lines with 70 plants in each. The unit adopted was a double line 10 plants long, *i.e.*, 20 plants. The block was divided so as to give 7 columns each containing 40 units lying side by side.

The probable error was calculated for various combinations and arrangements of these units, each field being taken separately. It is not proposed to give the figures in detail but only the main results with the figures for the three fields combined. In the tables that follow the figures representing the size and shape of the plots indicate the *length* and *breadth*, respectively, *in plants nine inches apart each way.*

Some results for plots of various sizes and shapes are given in Table IV, which shows the probable error of the difference between two plots—(*a*) *adjacent*, (*b*) *any two at random*—in the same field.

TABLE IV.

Plot	Probable error between two: (a) Adjacent	Probable error between two: (b) At random	No. of plots
10 × 10	6·5	10·3	168
50 × 2	3·1	6·8	120
20 × 10	5 5	9·2	72
50 × 4	3·3	6·4	60
20 × 20	5·4	8·5	36
50 × 8	4·0	6·1	30

The long narrow plots are very distinctly more accurate than those that are square or more nearly so. In all cases the error is much less for adjacent plots than for any two at random. This difference, as might be expected, is much more marked in the case of the very narrow plots.

In a repetition series, where several strains are repeated in an orderly manner, so as to give a regular distribution of each over the whole area, the relative accuracies of different types of plot may not be the same as for comparisons of single plots.

Another point of interest also arises. In ordinary practice it is often necessary to compare together, or with a standard variety, a large number of strains. It is a matter of importance to know, for whatever system is adopted, whether the accuracy is affected by the number of strains included in one series. Is a repetition series of few strains, with the different plots of each strain comparatively near together, more accurate than one in which the plots are more scattered, through the inclusion of a large number of strains?

In order to throw some light on these points calculations of the probable error were made for arrangements representing repetition series of various numbers of strains. Thus for two strains alternate plots were taken together for the required number of repetitions, for seven strains every seventh, etc. Table V gives the results of such repetition series for several types of plot.

TABLE V.

Plot	No. of repetitions	% Probable error of difference between two			
		2 strains	7 strains	11 strains	28 strains
10 × 2	5	3·8	3·5	4·2	4·7
10 × 4	5	2·7*	3·5	3·8	4·1
10 × 10	4	3·2	3·5	3·7	
10 × 2	10	2·6	2·5	3·1	2·8
10 × 4	10	1·9	2·5	2·4	
10 × 2	20	1·9	1·7	2·3	

With regard to the number of strains in one series, the results are somewhat variable but, on the whole, it appears that with a large number of strains the probable error is increased, though only to a relatively small degree. This, of course, applies only to the

special conditions of this experiment where the plots were smal and each series was confined to one field.

As regards type of plot, the results indicate little materia difference between plots 10×2, 10×4, and 10×10. Wha difference there is, is in favour of the broader plots. It may be note that the figure marked with an asterisk, in the 10×4 results, probably too low. In this case one field, of the three of whic the combined results are given, gave a much lower figure than th other two, thus reducing the combined figure. The inference i that this figure is less reliable than the others, with which it doe not agree very well, and that it would probably fall into line wit them if further trials were made. The same applies to the figure fo ten repetitions of the same plot and arrangement.

There is obviously no point, so far as accuracy is concerned in reducing the width of the plot to as little as 2 plants. Anythin from 4 to 10 plants wide should be satisfactory for repetition series.

A comparison of Tables IV and V shows, on the whole, ver similar results. Thus single plots 50 plants in length, adjacent give about the same results as 5 repetitions of plots 10 plants i length. There is a slight difference as regards width of plot; i the single long plots the narrowest are slightly more accurate, whereas in the repeated short plots the variation, which is less distinct, is in favour of the wider plots.

An attempt was made to employ plots 50×2 plants, with 9 inch spacing, in actual practice, but it was a failure as the stand wa ruined by an exceptionally bad attack of crabs. It is obvious that in such small accurately spaced plots a few blanks will materially affect the results. Though a very even full stand can generally be obtained, there is always a fear that crabs may do some damage, a occasional attacks have been experienced both at Coimbator and in Tanjore. It was therefore decided to try rather larger plots modified so as to do away with such accurate spacing, but maintaining the long narrow shape.

A preliminary trial was made on the Manganallur Farm i Tanjore District. Three widths of plots were used, *viz.*, 5, 10, and 2 links; they were all 120 links in length. Interspaces of one link were

ft between the plots, which were planted right up to the edge of the interspaces. No definite spacing was done but the inside of the plot was filled up by ordinary planting at about 6 inches apart. The results obtained from a number of plots of each width are shown in Table VI as the probable error of the difference between *any two* plots in the same field.

TABLE VI.

Plots 120 *links long.*

Plot width	% Probable error between two	No. of plots
5 links	5·8	42
10 ,, ...	5·3	26
20 ,, ...	5·7	35

There was little difference between the three widths, showing hat this factor might be made very largely a matter of convenience ith regard to planting, harvesting, area of land available, etc.

Further trials were made, on the Central Farm at Coimbatore, ith plots 50′ × 4′ with 1′ interspaces. The planting was roughly ″ apart, giving 9 lines to each plot. The spacing was not done ccurately, by measurement, but 9 lines were planted between rings placed 4′ apart, the outside lines touching the strings. Seven elds were planted in this way, and the probable error for the differ- nce between *any two* plots in the same field is shown in Table VII.

TABLE VII.

Plots 50′ × 4′.

Field	No. of plots	% Probable error between two
1	16	6·4
2	13	5·1
3	11	8·6
4	11	6·8
5	13	8·2
6	14	5·8
7	12	5·5
Combined	90	6·5

The results for the separate fields are as uniform as could be expected for such small numbers of plots, and the combined figure for 90 plots, 6·5 per cent., may be taken as sufficiently accurate for such plots at Coimbatore. The combined figure for *adjacent* plots is 4·2 per cent.

Further results were obtained from actual trials of strains carried out on the Paddy Breeding Station, in which plots 50′ × 4′ were employed. Each strain was repeated twice in a number of fields. In calculating the probable error the two plots of a strain in the same field were taken as duplicates. By working the differences as percentages it was possible to combine them into one lot and get a figure for the series as a whole. Table VIII gives the results for three such series. They agree very closely with those of Table VII.

TABLE VIII.

Plots 50′ × 4′ in actual trials.

Series	Pairs of duplicates	% Probable error between two
III, 17-18	29	6·2
IV Do.	49	5·9
VII, 18-19	27	6·9
Combined	105	6·6

It is desirable, where possible, to repeat each strain at least twice in every field; a check on the results can then be exercised by calculating the probable error as above. From the point of view of accuracy of the experiment, however, this is not necessary, but each strain should be repeated the same number of times in any one field as this avoids the variation in cropping power of different fields.

The above results for 50′ × 4′ plots (Tables VII and VIII) compare very favourably with those for the small regularly spaced plots of 50 plants in length (Table IV). There are several practical advantages in favour of the former, and for the present these 4′ wide plots have been adopted on the Paddy Breeding Station at Coimbatore. This is a convenient width for one cooly to work both in planting and harvesting; strict supervision is easy and

the work can be carried on rapidly, an important point where large numbers of strains are dealt with.

The length employed varies, according to the size of the field, from 40′–60′, the number of repetitions being adjusted accordingly and varying from about 8 to 12. The area required for each strain is about 5 cents excluding the borders of the field. Any number up to eight strains are included in one series.

The accuracy of such tests has been worked out in a number of cases. The probable error of the difference between any two plots was calculated from the figures for duplicate plots in the actual experiment, as for Table VIII. This figure was then divided by $\sqrt{n}$, n being the number of repetitions, to get the probable error of the difference between any two strains. Six out of seven results lie between 1·9 per cent. and 2·4 per cent., the seventh being 4·0 per cent. All these were on land that had been under observation for only about two or three years. On thoroughly known and selected land it should be possible to work the above system with a probable error of about 2 per cent.

THE "FRASH" (TAMARIX ARTICULATA).

BY

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In my early school-days, as we sang the "Scottish Blue-bell," I sometimes envied the "proud Indian," his "boast of jessamine bowers—the mountain, the valley with all their wild spell." The poet's picture of the rich East was too fascinating—it overshadowed the blue-bell. I have since learned that envy need not have hushed a note of the song. The jessamine blooms in the market garden under the "city wall," and mingles its heavy-sweet with the odour of the bazaar. But there are valleys in India that glow and swelter in ultra-tropical heat, yet which bloom fresh and fair during several months of the year. A large part of the Peshawar District comprises one of those favoured vales. Here, blessed by copious irrigation, the fields are more or less green always, and the landscape is graced by charming groups and lines of trees. It is in praise of one of these trees, the "ghaz" of the frontier, that I would write. Throughout the Punjab it is known as the "frash." Brandis calls it *Tamarix articulata*, and notes that it is found beyond India, in Afghanistan, Persia, Arabia, and even in North and Central Africa. Some among us who have enthusiastically hunted for herbarium specimens may have discovered an ally of the "frash" on the coast of England. My introduction to the family was by the lake at Kew. From Delhi to the Khyber, by the Grand Trunk Road, and over the yellow plains, or uprising columnar from the corn-fields, the "frash" is a familiar tree. (Plate XXVII.) On this wide area, when the district officer despairs of establishing the

PLATE XXVI

shisham (*Dalbergia sissoo*), the mulberry, the poplar, the *ber* (*Zizyphus jujuba*), or even the *kikar* (*Acacia arabica*), he hopefully plants "frash," and the good tree rarely disappoints him, be the land wet or stony, deep and fertile, or even a salt-stricken plain. The cultivator in the Punjab and the North-West Frontier Province knows all about the "frash." He understands how to propagate it, and no tree is more easily raised, nor is stock of any more abundantly to hand. When it is desired to establish a boundary line between two villages, or to demarcate holdings, stout cuttings are planted *in situ* during the spring or when rain falls in August, in the confident knowledge that despite neglect, these will grow and ultimately win from the camel and the goat, the grasshopper, the village boy, or the ubiquitous white-ant.

On a fine spring morning the Peshawar valley is beautiful, fresh and sylvan. The coppiced "frash" and spreading mulberry embower the hamlet, sentinel trees stand out in the corn; the roads and the canals, the streams and water courses are traced in lines of dark pine-green, with here and there the brighter hue of tender new-clad mulberry and *shisham*. The humble cultivator is the artist who has made the landscape beautiful. He has silently, patiently, of his own free will planted "frash" to shelter his crops and cattle, to supply beams for his dwelling or fuel for the home, to provide money to marry his children.

The mulberry is the "Old Apple Tree" of the Pathan boy and girl, their leafy school of Nature-study; the tree in which they perched as they watched the ripening corn, or under whose cool shade they played and slumbered. But the "frash" is the household's friend—the "Codlin" *and* "Short" when crops fail or the cattle are afflicted, when ready-money is demanded. Most frequently the mulberry is self-sown. Like Topsy it "just growed" and the family gathered round it as its sheltering arms extended. Unlike the dwarf species of the lazy river-flat, the "frash" of the field is never a natural seedling in the North-West Frontier Province. Every tree has been planted as a cutting. Had it been necessary for the cultivator to sow seed and carefully raise seedlings, or procure these from a nursery, it is probable that the trees of the Peshawar

valley and a large part of the Punjab would at the present time be confined to the roadsides and canal banks. It is certain that wthout the "frash" the fuel supply of North-West India would be far more scanty than it is now. During the period of the war this copse-wood has proved a "mortgage-lifter" to many Peshawar cultivators; the woodman has been busy around the villages since 1914, providing fuel for the troops on the frontier.

By the roadside on good land there are trees which are more satisfactory than the "frash." Admirable as the tree is in the field or by the village lanes, few will disagree with the writer who not long ago stated in the *Civil and Military Gazette* that the time had come when the "frash" should go from the city and cantonment. Trees that are propagated by cuttings develop a shallow root-system and are blown down more readily than those that are raised from seeds. The "frash" is the first tree to fall before the dust-storm. Then in these days of whirling motor cars and trains of motor lorries, the roadside "frash" becomes dust-laden and unpleasing. It is no longer suitable for the roadside, it is the cultivator's tree, it is a copse-wood. Grown old, tottering and gaunt, it is picturesque but hardly a shady roadside tree. Yet the "frash" can and should be young and fresh always, for no matter how large its limbs may be, these soon break into vigorous growth when they are pruned. Even the neglected fallen trunk by the wayside mantles in tender purple and green for several years after it is laid low.

The "frash" is also useful in some minor ways. The fruit-grower has found it an excellent wind-break for his orchard. A very promising hedge which was grown from cuttings and is less than 2½ years of age is shown in the accompanying figure. Sometimes the bark of the trees is used by the villagers in tanning, and this is another reason why the "frash" should not be planted on public highways, especially in tracts where other trees are scarce. A considerable quantity of tuberculate galls from which a dye may be prepared, is borne by the "frash," and in March and April the village girls may be seen collecting these from under the trees.

There are surely few agricultural tracts where the small farmer unaided by the State, has made what might have been a bare country-

side one of sylvan beauty. But the cultivator of the Peshawar valley has done this, and he deserves commendation for his choice

A wind-break of "frash." It was grown from cuttings and is less than 2½ years old.

of the "frash," a copse-wood that is beautiful and useful. He has done his part in providing a continuous supply of timber that fulfils his requirements, and meets a considerable part of the local demand for fuel and light beams. In the establishment of plantations the expert sylviculturist may prefer to use rapid-growing "soft woods," but no tree that is grown from *seed* will easily displace the "frash" in the favour of the North-West Frontier Province cultivator.

NOTE ON AN OUTBREAK OF SURRA AT THE GOVERNMENT CATTLE FARM, HISSAR, AND ON CASES TREATED.

BY

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SURRA has been the cause of such serious losses in the last few years that an account of its spread to this tract may not be without interest.

No case of the disease, so far as I am aware, had ever been diagnosed at Hissar previous to 1917.

The district, with the exception of parts of the Sirsa and Fatehabad Tahsils through which the Gugger river flows, so far as is known, has always been surra-free. No doubt surra-infected camels have occasionally been imported into the district from the neighbouring surra-infected areas of Ferozepore and Patiala, but there is no record of anything in the shape of a surra outbreak ever having occurred, and local camel-owners are not familiar with the disease.

This farm has been in charge of the Civil Veterinary Department since 1899, and has always maintained 8 to 12 riding camels, and since 1902 a considerable number of pony, mule and donkey stock. There is no record previous to 1917 of any animal ever having contracted surra.

Hence there is very little doubt that the outbreak, the subject of this note, owes its origin to the concentration of camels in Government Camel Corps at Hissar in 1917.

The 6th Government Camel Corps had its headquarters at Hissar from January to December 1917, and the 2nd Government Camel Corps from July to September 1917.

I do not think, under ordinary conditions, the posting of camel corps to Hissar, even if heavily infected with surra, would have involved much risk to susceptible animals in the neighbourhood; but on this occasion not only were the camels heavily infected with surra, but the district was also deluged with altogether abnormal rains, and consequently biting flies, capable of transmitting surra, were also abnormally numerous.

The year's rainfall amounted to 41 inches against an annual normal of 14 inches.

Approximately 11 inches of rain fell within 24 hours on 21st and 22nd August.

The 6th Government Camel Corps originally consisted of camels from Hissar District, and, except for one troop recruited from Sirsa Tahsil, was probably surra-free. Cases of surra were diagnosed in this troop early in the hot weather.

This corps left on field service in May, the surra-infected troop remaining at Hissar at the depôt. At the end of June a portion of the 2nd Government Camel Corps (4 troops) arrived at Hissar from Ferozepore. This corps since its inception had always had an exceedingly bad record as regards surra. Later other drafts of camels arrived at Hissar from other districts, including many surra-infected animals. Biting flies, including Tabanidæ, were unusually prevalent in August, September and October, and surra spread amongst the corps camels with such rapidity that by the end of October the disease had been diagnosed in almost every animal.

The camels were located on the borders of the farm, near an area habitually much grazed over by farm mares and camels. Orders were given not to graze farm animals in this vicinity, and young stock mules and donkeys, which usually go into lines in the same neighbourhood during the rains, were kept away in their winter paddocks. These orders, however, as regards grazing, were not effectually carried out. The danger area was only half a mile from the Home Farm to which all mares come at night, and on [illegible] occasions they stampeded there from other grazing grounds. Also at least on one occasion a farm camel which had strayed was caught grazing there. It is probable farm animals visited this area on

other occasions unknown to me, as it is impossible to get attendants of the class the farm is able to employ to understand the danger susceptible animals run by grazing in a surra-infected area, and if they did understand it, most of them are too careless and irresponsible to take any trouble to avoid it. The risk of infection was increased by corps camels occasionally straying and getting on to farm land.

From September on, the farm camels were kept under close observation with a view to the detection of surra, but it was not til 2nd October that the disease was definitely diagnosed in any of them. On that date No. 13 was found to be affected.

All the farm camels (8 in number) were immediately sent out to a camp in the middle of a dry grazing area some miles from any other susceptible stock, the affected animal was isolated and treated. Surra was definitely diagnosed in three more of the camels as follows :—In No. 14 on October 12th, in Nos. 9 and 12 on October 23rd.

All the camels were in fair condition. No. 13 was fat. The affected animals were all treated, details of which will be found below. The other four camels have remained surra-free up to the time of writing (February 1919).

The presence of the disease in farm camels caused acute anxiety as to other susceptible farm stock.

At that time there were present in the Home Farm 29 pony and 34 donkey mares with foals at foot, with one pony filly running with them, twenty-four pony mares without foals, 9 mule and 4 donkey foals weaned on October 15th (up to October 15th had been running with other mares and foals), 100 donkey mares and fillies, 3 Arab mares, 10 to 12 mares in foaling or hospital boxes, 7 donkey and one horse stallion in boxes. There were also 3 pony mares, 2 mule foals, and a donkey colt, in an isolation line about half a mile from the Home Farm; the mares had been in the Home Farm till the beginning of October.

There were also 182 young stock mules and donkey colts in paddocks about half a mile from the Home Farm, and 11 pony and 25 donkey mares all heavy in foal at Chowni about 2 miles away.

The majority of the above animals were unbroken young stock.

The small veterinary staff at my disposal was very fully occupied with outbreaks of rinderpest and hæmorrhagic septicæmia among farm cattle, in addition to abnormally heavy ordinary hospital case work.

I was only able to spare one man to assist me in surra-detection work.

All the animals in the Home Farm, in the isolation hospital, had temperatures taken morning and evening daily, with the exception of the 100 donkey mares and fillies which were dealt with on alternate days.

Blood from all animals with suspicious temperatures was examined on the spot.

Surra was detected in the following animals on the following dates :—

Pony mare No. 57 on October 16th (mare had a foal at foot).

Pony mare No. 73 on October 17th (had foal at foot).

Pony mare No. 98 on October 18th (this mare was in the isolation hospital. She had a foal at foot).

Donkey mare No. 88 on October 18th (had a foal at foot).

Pony mare No. 130 on October 18th (foal had been weaned on October 15th).

Donkey mare No. 6 on October 18th (had a foal at foot).

Pony mare No. 74 on October 27th (foal had been weaned on October 15th).

These mares were all in the Home Farm and had all been grazing together up till October 15th. After detection of the first case, the whole herd was kept up and stall-fed in lines where they could get into cover in the day time to escape biting flies.

During October I was unable to pay much attention to the animals in the paddocks and at Chowni, but on November 10th, mare No. 49 at Chowni was found to have surra, and mare No. 124 on the 11th. These mares had been moved to Chowni from the Home Farm on September 10th.

From November 11th, 1917, up to date (February 1919) no more cases of surra have been detected on any animal in this farm.

Of the above cases, pony mare No. 57 and donkey mare No. 6 were destroyed; the remaining animals were treated.

Before proceeding to details of treatment which will be found below, the following points seem to me to be of interest.

Period of incubation. In equine surra, I believe, this is said not to exceed 10 days. The disease was detected in pony mare No. 74 on the 27th; the last previous case among animals with which she was in contact was detected on the 18th. From the 17th onwards mare No. 74 and her companions were kept up and stall-fed and had shelter from biting flies. It is probable the mare was infected before the 17th, and as she was free of trypanosomes between 17th and 27th and the period between paroxysms does not usually exceed 10 days, it is probable that the disease was diagnosed in the first paroxysms.

Probably in natural cases the period of incubation may exceed 10 days.

Susceptibility of foals. I believe there is a superstition among camel-owners in surra tracts to the effect that young camels under their mothers are immune to surra. Leese, I believe, proved that age had no effect on the susceptibility of camels to surra, but in the light of my experience in this outbreak it seems probable that young stock do naturally escape surra more frequently than their parents. Possibly their thick woolly coats may be some protection against the biting fly.

At all events in the above outbreak no foal contracted the disease, and all the pony and donkey mares affected either had foals under them at the time the disease was detected or had them weaned from them a day or so before.

Mares Nos. 98, 73 and 88 were treated and their foals accompanied them to the isolation hospital, and so remained in contact with the disease for a long period. Biting flies too were numerous up to the end of October.

Agent of transmission. In this outbreak everything points to a "tabanus" as the agent of transmission. The common biting

flies of the district are *Stomoxys*, *Lyperosia* and *Hippoboscidæ*. Tabanidæ can generally be found near water in the hot weather and rains but as a rule is not a common fly.

In 1917, during August, September and October, Tabanidæ were numerous; *Stomoxys* and *Lyperosia* were swarming everywhere.

At the time surra was diagnosed in pony mare No. 98 she was with two other pony mares Nos. 80 and 60, her own and another foal, and one 3-year old donkey colt. No. 60 mare is a light roan. *Stomoxys* and *Lyperosia* were so numerous that the roan mare was literally black with them in the morning and evening. Drops of blood from fly punctures on the animals could be detected at any time on any of the animals. These mares and foals remained several months with the surra cases under treatment, but none of them developed surra.

(*a*) As an item of interest, in the cases of the above blood examinations, Filaria were detected in the blood of only two, both pony mares. In one of the mares the worm was only detected on one occasion, although her blood was examined daily for two months.

(*b*) I had fully expected, if the monsoon of 1918 proved heavy, to experience another outbreak of surra, or at all events to hear of the disease in the neighbourhood, as the camel corps camels were camped in close proximity to a much frequented road, and must have infected many local camels which had to pass right through the camp to get into Hissar.

As a matter of fact monsoon rains were light, nothing was heard of surra in this district in 1918, but the disease is often so chronic in camels that it is quite probable camels infected in 1917 will be alive and be a source of danger to the district in 1919.

Details of treatments.

The following are details of treatments employed.

The large doses of antimony tartrate used intravenously were tried on the recommendation of Lieut. W. A. Poole, I.C.V.D., I.A.R.O., at the time acting as Camel Specialist. I understand large doses in camels were first tried by Mr. H. E. Cross, when that officer was Camel Specialist, with very encouraging results.

Donkey Mare No. 88 was treated by the arsenic alone method, after 3 grm. of soamin had been injected subcutaneously to drive the trypanosomes from the circulation; beginning with 0·750 grm. in bolus, the mare received 20·25 grm. of arsenic in 19 days. The arsenic was given on alternate days. The last dose was 3·25 grm. The mare weighed about 450 lb. She died of arsenic poisoning on the 24th day. There had been no return of trypanosomes to the circulation.

Pony Mare No. 74, weight 697 lb., was treated as above; beginning with 4 grm. soamin subcutanecusly on October 27th. she received 38 grm. of arsenic in 23 days, the last dose being 4·75 grm. This mare was for a long time regarded as cured; by December 7th her weight had increased to 770 lb.

In April 1918 she was put on to light work; her temperature was, however, still taken night and morning, and her blood was examined weekly.

On February 21st, 1918, her morning temperature was 102·6°F. On the same evening it was down to 101·2°F. At that time her blood was being examined daily, and there was no sign of trypanosomes in the circulation.

Except for that one occasion, the mare's temperature remained normal till July 10th, when her morning temperature was 102°F. and trypanosomes were found present in the circulation. The mare was given 300 c.c. of a 1 per cent. solution of antimony tartrate intravenously. The dose proved too big and she died on July 11th, 1918.

The mare had visibly lost condition during June.

Pony Mare No. 130 was treated, to commence with, as above. The arsenic in bolus was increased from 1 to 5 grm. in 20 days, but trypanosomes appeared once during treatment, and again 3 days after the treatment was stopped. The treatment was repeated and 10 doses in 20 days were given, being increased from 4 to 7 grm. of arsenic. Trypanosomes reappeared 5 days after treatment. The mare was next treated with soamin subcutaneously, antimony tartrate intravenously, and arsenic by the mouth; 0·7 grm. of antimony tartrate was the maximum dose of that drug given. The

mare remained free of trypanosomes for 22 days. She was then treated by antimony tartrate alone, and received up to 200 c.c. of 1 per cent. solution intravenously. She remained free of trypanosomes for 41 days after the treatment ended. She was eventually poisoned in an attempt to find out the safe dose of antimony tartrate intravenously.

This mare was in poor condition when treatment began, but improved in condition all the time.

She was fat when she died. Her normal weight was about 800 lb; shortly before her death she weighed 860 lb.

Pony Mare No. 49 was treated on the same lines as the above: doses of arsenic in the first treatment were rapidly increased from 1 to 5 grm., but trypanosomes appeared twice during treatment and immediately after. After combined soamin, arsenic and antimony tartrate the mare only remained 13 days free. She was eventually destroyed. She was in poor condition when treatment commenced, and weighed 700 lb. on 10th November. She improved in condition, and on the 16th December weighed 824 lb., part of the increase in weight being due to the fact that she was in foal.

Shortly before she was destroyed she slipped her foal; she carried the foal to within one month of the normal gestation period.

Pony Mare No. 98, to begin with, was treated in the same way as above cases, and like them received very large doses of arsenic in bolus (up to 6·5 grm.). This mare, to start with, was in fair condition and tended to improve, but arsenic alone had little effect on the trypanosomes which appeared in the circulation during treatment. Combined soamin, arsenic and tartrate emetic (small doses) gave only slightly better results.

On February 9th treatment with antimony tartrate alone was begun. 250 c.c. of 1 per cent. solution was injected intravenously. The dose was repeated on February 12th, 15th, 18th 21st and 24th.

Trypanosomes reappeared in the circulation on M[illegible] 16th. On that date 180 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously; a larger dose had been proposed, but the injection was stopped owing to the mare exhibiting signs of distress.

On May 19th 400 c.c. of 1 per cent. solution was injected. Since that date the mare has had no rise of temperature, and trypanosomes have not been detected in the circulation. Her blood was examined almost daily up to October 31st, 1918, and two or three times weekly since.

A rabbit was inoculated with 10 c.c. of blood from this mare on November 22nd, and has remained healthy to date (February 1919).

The mare weighed 792 lb. on the 10th December, 1917, and 830 lb. on 1st May, 1918.

Pony Mare No. 73, to begin with, was treated in the same way as the above.

She received up to 6 grm. of arsenic in bolus. Trypanosomes reappeared in circulation, 12 days after conclusion of treatment.

Combined soamin, arsenic and antimony tartrate (small doses) gave no better results.

Combined prolonged treatment with soamin, arsenic and antimony tartrate, using larger doses of antimony tartrate, was begun on January 18th, and concluded on March 14th. As always in these cases, soamin was given subcutaneously, arsenic by the mouth, and antimony tartrate intravenously. Up to 200 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously. The mare remained free of trypanosomes until May 25th.

On May 25th, 320 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously. A larger dose was intended, but the mare's jugular glands were sore and she was fidgety under manipulation, and some of the solution got under the skin. A considerable swelling resulted, and the mare was off feed for several days. No further injections have been made to date. Trypanosomes present on the 25th May disappeared a few hours after the injection was made and have not reappeared. The mare's temperature also has remained normal. On November 22nd a rabbit was inoculated with 10 c.c. of blood from this mare. The rabbit has remained healthy.

The mare has maintained fair condition; on the 9th December, 1917, she weighed 768 lb. and on the 1st May, 1918, 860 lb.

Pony Mare No. 124 was heavy in foal when treatment began on November 11th. She remained free of trypanosomes for 20 days

after arsenic alone treatment. The maximum dose of arsenic was 5·5 grm.

The mare weighed 684 lb. on November 11th and 760 lb. on December 9th.

Combined soamin, arsenic, and antimony tartrate was begun on January 21st and continued till February 15th. The mare gave birth to a healthy full-time foal on March 18th. During March, before the mare foaled, several doses of soamin (subcutaneously) were given. The mare had plenty of milk and the foal did well, but trypanosomes reappeared in the mare's blood on April 29th.

On that date an injection of 300 c.c. of 1 per cent. solution antimony tartrate was made intravenously.

She remained free of trypanosomes till September 29th, 1918. On that date she was given 4 grm. soamin subcutaneously.

Trypanosomes disappeared and did not reappear till November 11th; 4 grm. soamin was again injected. Trypanosomes reappeared on November 21st.

5 grm. soamin was given subcutaneously. Trypanosomes have not reappeared up to date (February 1919).

The foal, now 10 months old, has done exceptionally well since birth, and is now about the finest male foal of his age on this farm.

Camel No. 9. Trypanosomes were first found in the circulation on October 24th, 1917. He was treated by combined soamin subcutaneously and arsenic intravenously, as recommended by the Camel Specialist's extant reports. The treatment concluded on Nov. 11th with 1·5 grm. arsenic intravenously and the camel off his feed. The camel fed again on the 12th, and has not been sick or sorry since up to date (February 1919). On December 10th, 1917, he weighed 1,208 lb.

His blood and temperature were examined twice weekly till December 1918, and trypanosomes have never been detected in the circulation since October 24th, 1917.

A rabbit inoculated with 10 c.c. of blood from this camel on November 27th, 1918, has remained healthy.

Camel No. 12. Trypanosomes were detected in the circulation on October 23rd, 1917. He was treated in the same way as camel

No. 9, and like camel No. 9, 15 grm. of arsenic intravenously, his last dose, put him off his feed for one day.

He has never been sick or sorry since. He was kept under observation up to December 1918. 10 c.c. of his blood was inoculated into a rabbit on November 22nd. The rabbit remains healthy.

Camel No. 14. Trypanosomes were detected in his blood on October 12th, 1917. He was treated in the same way as above and has remained healthy up to date. The rabbit inoculated with his blood on November 22nd, 1918, also remains healthy.

Camel No. 13. A Dachi. Trypanosomes were first detected on October 2nd, 1917. The arsenic and soamin treatment was not successful. Trypanosomes reappeared in the camel blood on December 9th, 45 days after the first treatment concluded.

The treatment was repeated, using small doses of antimony tartrate intravenously alternated with the arsenic doses.

Trypanosomes again reappeared 45 days after treatment concluded.

On February 14th, 1918, the camel received intravenously 250 c.c. of 1 per cent. solution of antimony tartrate. This dose was repeated on the following dates:—February 16th, 18th, 21st. 26th, March 4th, 8th, 13th and 17th.

Since February 14th, 1918, no trypanosomes have ever been detected in the blood of this camel. A rabbit inoculated on November 22nd remained healthy. The camel was kept under observation up to February 1919 and will remain under observation as opportunity permits.

All the above camels were put into regular work immediately after treatment concluded, and on some occasions worked while under treatment.

All are now in very good condition.

The Dachi No. 13 was always from the first in fat condition. She weighed 1,422 lb. on the 10th December, 1917.

All the above cases, except for one month when he was on leave, have been in the charge of Veterinary Assistant Ata Mohammed (now 2nd Farm Overseer on this farm); while he was

away they were in my sole charge. Nearly all the doses to equines were given in my presence or by me. The camels were treated (except for the one month) entirely by Veterinary Assistant Ata Mohammed, whose previous experience of the disease while serving under the Camel Specialist came in very useful.

The above results appear to me to be decidedly encouraging, while in the light of our present knowledge of surra I hesitate to claim definite cures, hasty condemnation of treatment should I think, be deprecated.

THE IMPROVEMENT OF INDIAN DAIRY CATTLE.*

BY

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THE improvement of the milch cattle of India has occupied considerable attention in recent years, both at the hands of the departments of agriculture and of the public. It is noteworthy that, in fact, all questions connected with dairying are receiving an increasing amount of attention and study, so much so that dairy husbandry and the problems connected therewith, promise to become one of the foremost among the various branches of agricultural study in this country. We have already a fair number of large and well-equipped dairies conducted mostly by the Military Department, where milk is handled in large quantities, cream and butter made by up-to-date methods, and even the manufacture of cheese taken up. There is a goodly amount of business done by importers of dairy machinery, chiefly of cream separators and butter churns. We have a Dairy Farmers' Association in the country conducting a journal devoted to dairying matters, and an examination for the National Diploma in Dairying has been instituted which bids fair to become a coveted honour among our agricultural graduates. There is also a growing amount of recognition by Government, for some of the provincial departments of agriculture are being strengthened by the appointment of specialists in animal husbandry. Recently, too, His Excellency Lord Willingdon gave a strong impetus to the industry by himself setting an example to the landed

* A paper read at the Sixth Indian Science Congress, Bombay, January 1919

aristocracy of India, in the matter not only of keeping high grade dairy herds on their home farms but also of building up such a herd by steady improvement.

The industry indeed is in such a backward condition and the need for improvement so great and urgent that we require all this and a great deal more of public attention bestowed on this subject. The problem of milk supply in cities is becoming every day more acute, while even in parts of the country noted for their dairy products, milk, butter and *ghee* are becoming scarce and high priced, and such as is available is often foully and shamefully adulterated. More milk and wholesome milk has to be produced at prices not so high as to make it beyond the reach of all but the well-to-do classes of people. The prices of dairy cattle and of feeds and fodders have gone up, and it seems to be admitted on all hands that the city dairyman is by no means a prosperous individual—oftentimes hopelessly in debt, and at best only making a hand-to-mouth existence.

The problem has been studied by many people, and various recommendations such as may be suited to different local conditions made. The most important among such recommendations are, firstly, the production of milk not in the cities themselves but on special farms, or as part of general farming, out in the country and the transport of the milk to the city for sale, a measure much the same as one finds in European and American cities and requiring quick transport, the organization of wholesale depôts, refrigerating arrangements, and so on. This indeed is bound to come, for it is, I venture to think, one of those changes which are brought about automatically by the growth of cities of the modern type. The second recommendation is the improvement of the milking quality of the animals themselves, *i.e.*, the breeding of a superior type of milk animal. The importance of this recommendation is too obvious to be emphasized, for the average Indian cow or buffalo seldom yields milk enough to pay for its keep.

A surer means of lifting the industry out of its present unsatisfactory condition than this one of breeding a superior type of animal cannot be thought of. When, however, we come to decide as to the method by which we have to attain this end, we are faced with

several difficulties. Shall we confine ourselves in this matter to the indigenous Indian breeds selecting the best among them, and continue the process of selection and weeding out until we get together a type considerably superior to the general bulk? There is no doubt much to be said for this method. Speaking of our own Mysor cattle, it is not uncommon to find cows yielding nearly 4,000 lb of milk in a lactation period, and if this is a measure of the improvement possible in a general herd, it will be no small achievement if we can breed by selection alone such a type. There is again the further advantage of suitability of the breeds to their tract, for they are native to it; and, furthermore, there is the certainty of a handsome price for male calves, for these grow into a much-prized type o draft bulls. The method is however very slow, as it will take several generations of cattle to raise the level of even a picked herd. Shall we then adopt the method of crossing the local cow with English or Australian sires of reputed milking breeds? The production of animals with considerably increased milking capacit by this method is exceedingly quick, for the very first generation of the cross-bred cows shows the improvement very strikingly indeed. It is this somewhat tempting prospect of being able to collect togethe within a period of, say, some three to five years a herd with th high milking quality we desire so much that constitutes the merit of this method. One has only to keep a good British or Australia sire—as a matter of fact the Ayrshire seems to be the one mu thought of for this country—in a herd of local cows, and wait th short period of three to five years when the offspring born of these two breeds grow and become milkers themselves.

The improvement in the milking quality of the offspring ove that of their pure bred country mothers is really remarkable, a may be within the experience of all who may have compared th milk yields of such animals, so much so that it would seem indee that the cross-bred cows would solve the problem of the milk suppl in cities, at any rate, as far as the production of milk is concerned. Shall we take it then that those of us who have charge of breedin stations for dairy cattle should concentrate our efforts in this parti cular line of breeding in preference to grading up indigenous cattl

by selection through several years? This I need hardly point out is a most important matter to decide, for it involves the breaking of the type of Indian cattle and the introduction into the country of a mixture of types, a measure which can certainly not be decided upon except with the fullest knowledge of the consequences. I make this the justification for my venturing to make a few observations in regard to the limitations and difficulties of this method of breeding. I do not refer to the comparatively greater susceptibility of these cross-bred cattle to the cattle epidemics of India, though that itself is a serious matter; for it may be expected that in the cross-bred herds kept by professional dairy farmers, the necessary precautions against these epidemics, such as inoculation, segregation and so on, will be attended to promptly.

I should like to invite your attention to a different aspect of the subject, *viz.*, the risk of disappointment if certain precautions are not taken, and the production of what I may call cross-bred scrub cattle which partake of the good qualities of neither breed and perhaps combine the bad qualities of both. It is a striking fact that the cross-bred offspring of the first generation invariably possess the good milking qualities of the breed to which the foreign sire belongs. Does this justify us in inferring that the milking quality behaves as a "dominant" in the Mendelian sense? I am aware that when we come to a character like the milking quality, which is the resultant of a number of factors in the constitution of an animal, and try to apply the principles of Mendelism to the manner of its transmission, we are treading upon thin ice. But these principles have been applied in the plant kingdom to several qualities of economic value, themselves the resultant of many factors, and I do not know if in regard to cattle, others have not sought to apply these principles to this very characteristic, *viz.*, the milking quality. If we are justified in considering this quality as a Mendelian "dominant," certain interesting conclusions follow which can guide us as to how best we can take advantage of the method on the one hand, and how we can avoid disappointment on the other.

Thus it ought to follow that (1) if we mate the pure-bred sire and one of the first generation cross-bred cows, all the offspring will

possess the dominant characteristic and will therefore be good milkers; (2) if however we mate the first generation cross-bred cow with first generation cross-bred bull, we ought to get in the progeny good milkers and bad in the proportion of 3 to 1. *i.e.*, 25 per cent. of the total must be, so far as the milking quality is considered, just as poor as the original country cow from which we started. All of them cannot be equally good by virtue of their being equal as regards the blood of the original foreign parent contained by them, but this 25 per cent. will be inferior to the remainder; (3) if again we mate a bull of the first generation cross with a country cow, that is to say, if instead of using a pure-bred foreign sire we use a first generation cross-bred bull as sire, in the herd we ought to get in the offspring good and bad milkers in the proportion of 1 to 1, that is, 50 per cent. of the total consist of poor milkers. So the proportion in this case is still further reduced. That is to say, although on account of the fact that the progeny in each case is alike as regards the degree of foreign blood in them, and breeders would say that they should consequently possess the milking or other quality in an equal measure, yet if our theory is correct, a large number cannot possess that quality. On these considerations it follows that except where we use a pure-bred foreign sire, whether it be on the pure local cow or on the first generation cross, in all other cases it will be somewhat of a toss-up as to what kind of animal we shall be getting, for, as stated above, we get both good and bad milkers. It is to this uncertainty or diminished chance of producing good animals, except where the above-mentioned precaution of using only a pure-bred sire is adopted, that I wish to invite your attention. I have come across many instances where cows evidently with foreign blood in them, as may be inferred from the suppressed hump and the broken coat colour, have proved no better than the local cows in their milking quality. Disappointments like this will increase if, as it once came under my notice, professional keepers of breeding bulls in and about the city try to meet the demand for a foreign sire by keeping only a half-bred bull instead of a pure bred, because a half-bred bull is the only one they can afford to buy.

There is then again the question of the bull-calves of this mixed progeny. In the case of pure bred local cattle, so far as Mysore is concerned, one of the chief sources of ready money to the farmer is his male calves, and with the city dairymen of Bangalore and Mysore the hope of obtaining a bull-calf from the cows is the only inducement to keep a cow which, so far as her milk yield is concerned, may be too poor to pay for her feed. The more nearly the bull-calf conforms to the popular taste in the matter of colour, physical configuration and other characters, the higher the price it fetches. This is only as I said in the case of the pure local breeds of cattle. In regard to bull-calves of cross-bred cattle, just at present at least, no buyer of draft cattle would as much as look at them. If they do find a sale, they fetch only the price of scrub cattle. The absence of the hump and the somewhat strange build of the frame and the broken colour and other features do not attract buyers. Popular belief *may be* wrong. These heavy and long bodied cross-bred bulls may be powerful animals, hardy as the local ones, and suited to the needs of the ryot. In fact a few cross-bred bullocks may be occasionally seen even in the countryside; while in cities, such bullock teams are frequently seen hauling heavy loads. It is, however, reasonable to expect that these beasts cannot be as hardy as the local breeds of bullocks, nor so capable of withstanding cattle diseases either, and in the hands of the ryot out in the villages the matter of inoculation against diseases or segregation cannot be thought of. It is, however, different with the cross-bred cows, for they are likely to be located in special dairy farms and looked after properly. It is this question then of the disposal of bull-calves, in a country where the slaughter of cattle except those which are unfit to live is considered a horrible sin, that has cooled the enthusiasm of many a dairy expert keen on the subject of cross-breeding.

Lastly is the fate of the scrub progeny of the cross-bred; we have seen that except in the cases where only the pure-bred sire is used, the offspring of cross-bred cattle cannot be all good milkers. The more we use other than pure-bred sires, the more are these uncertain cattle thrown out, both bulls and cows, the bulls possessing none of the characteristics prized by buyers of draft cattle and the

cows useless as milkers, and both being equally at a disadvantage as against pure country cattle in their susceptibility to cattle diseases. The only method of restricting the chances of such undesirable cattle is to arrange that cross-bred bull-calves are castrated at the breeding farms before the age when they can be of use as sires, just as we have been recommending for years past in the case of the undesirable male calves of the village cattle themselves.

The popularity of the cross-bred cow as a dairy animal is unquestioned and is steadily increasing. In a census I took some years ago of the dairy cattle of Bangalore this was strikingly brought out. The only reason limiting their more extended use is the loss they imply in their begetting bull-calves of practically no value. The fact that lately some among even the cross-bred cows have proved disappointing as milkers is further operating against their popularity and I believe it is due to the indiscriminate use of cross-bred sires instead of the pure-bred ones. The fact that in their outward appearance these cross-bred bulls resemble closely their pure-bred parent while their potency for mischief is not so apparent, is the cause of this mistake.

Probably we shall have to look to the cross-bred cow in this country more and more for the solution of the problem of the milk supply to cities, and I venture to think that the precaution of using a pure-bred bull either to meet the need of city cow-keepers or for the use of special dairy farms in the country, will minimize the risks and disappointments attendant upon the resort to this method of breeding cows for the milk trade of the country.

NOTE ON LAND DRAINAGE IN IRRIGATED TRACTS OF THE BOMBAY DECCAN.*

BY

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JUST as the conditions which determine irrigation practice in the Bombay Deccan differ in almost every essential from those which determine irrigation practice in Northern India, so the problem which confronts us with reference to land drainage differs in almost every essential.

Just as an irrigation engineer when he comes to the Deccan has to unlearn or forget a lot he hitherto looked on as the A B C of irrigation practice, so the officer in charge of drainage and reclamation can make little headway until he realizes that the problem to be faced is essentially different from what has been usually met with elsewhere.

In Northern India, I understand that—

(1) the salt pre-existed the canals;
(2) sodium carbonate gives most trouble;
(3) the soil is homogeneous; and
(4) the groundfall small.

In the Deccan—

(1) the damage may be said to be entirely due to the opening of canals;
(2) sodium carbonate is almost entirely absent, sodium sulphate and, to a less extent, chloride being in great excess;

* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

(3) the soils, subsoils and substrata vary excessively and abruptly; and

(4) the groundfall is very great (of the order of 1 in 150).

In the Deccan we are mainly concerned with six quite distinct types of surface soils and six distinct types of substrata, and these vary enormously in thickness, the change frequently being very abrupt.

From what I have said two points will be clear—

(1) that the conditions are excessively complicated; and

(2) that the problem is mainly one of preventive drainage

I do not propose to go into detail as to the difficulties met with and overcome, or the successive steps which led us to the conclusions arrived at, but will merely state broad facts.

As to whether some of the substrata are of colluvial or residual origin is still uncertain; but fortunately we can ignore this point for the moment.

Each drainage (*see* Cross Section) may be looked on as a valley once denuded of soil—and very much like any existing Deccan valley near the hills—which has been filled up with colluvial silt There are five distinct types of strata :—

(1) Soil—impermeable when wet, but which cracks when dry.

(2) Subsoil (upper)—(i) impermeable.

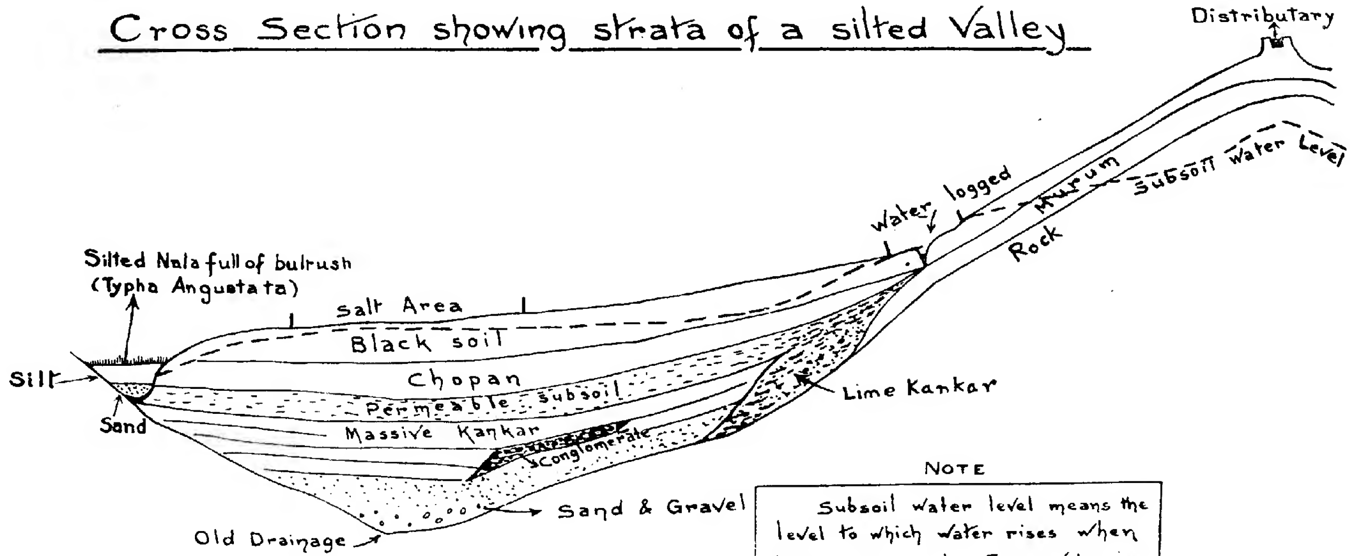
(3) Subsoil (lower)—(ii) moderately permeable.

(4) Substratum—very permeable and sometimes fissured.

(5) Fissured rock—slightly to very permeable.

Near the ridges there is a very thin layer of red soil overlying disintegrating trap rock—locally called *murum* from which it is derived. This *murum* stratum may be of considerable depth near the ridges and is excessively permeable. As we go down the sides of the ridges, we find that the surface soil gets gradually deeper both in colour and thickness, and when the *murum* becomes about 4 feet below the surface, a subsoil of yellowish red colour, locally called *chopan*, intervenes. At or near this point the permeable *murum* stratum usually dips sharply, with a consequent increase in the depth of the subsoil stratum. When this occurs we usually find

Cross Section showing strata of a silted Valley



NOTE

Subsoil water level means the level to which water rises when bores are sunk. Free water is usually not met with till the "permeable subsoil" stratum is reached.

that the subsoil is divided into an upper impermeable layer, and a lower slightly to moderately permeable layer, and the hard permeable top substratum changes to lime *kankar*, which towards the bottom of the valley changes to massive *kankar*, locally called *mán*.

We see then that we have three distinct layers of permeability, an almost impermeable upper layer of soil and subsoil, a slightly to moderately permeable subsoil, and a very permeable hard substratum, the latter very often being fissured. Bearing in mind the steep fall, it will be realized that, with such strata large quantities of water will pass, through the highly permeable layer and under the impermeable surface layer, into the valleys, and will pass through into any deep river or *nala* which cuts the permeable layer. On the other hand, if the permeable layer is not cut, or if it is of insufficient thickness to get rid of the accumulated water, artesian conditions will arise, the water being imprisoned under the impermeable surface layer.

This is exactly what we find in practice in our salt areas; and the salt is due to evaporation making a balance between water entering the subsoil, and the quantity that the natural drainage can get rid of. The amount that cannot drain away is in fact forced through the comparatively impermeable top layer until evaporation balances the excess.

As a rule, when we bore a hole in a salt area we do not find subsoil water near the surface. This is most marked. If, however, a pit is left for a couple of days, it will be found to contain water which has oozed in from the sides and bottom. This is because, as a general rule, we do not pierce the moderately permeable lower subsoil stratum till a depth of 5 to 10 feet is reached. At this level there is a sudden change, so that when the lower stratum is reached, water rushes in through the bottom of the bore hole with a hissing noise, and rises rapidly to near the surface, sometimes even pouring out at the surface. This level we call the level of "first strong flow."

When we first started this work one of our difficulties was to ascertain the permeability of soils and subsoils. Laboratory

experiments were obviously unreliable even for soils, and were quite useless for substrata. It was not until Mr. Thiselton-Dyer put me on to the 'post hole auger' which made it possible to bore holes rapidly into the subsoil, that the idea of measuring permeability by the rate of recuperation of subsoil water entered my mind. It is obviously the most perfect and simplest method to adopt, for the permeability of the stratum is measured *in situ*.

The coefficient of recuperation is measured by the formula :–

$$\frac{K}{A} = \frac{1}{T} \log \frac{H}{h}$$

where K = Coefficient.

T = Time in hours.

H = Full head of depression.

h = Head of depression after T hours.

A = Area of bore hole (which goes out in our case as it is constant).

Having obtained the level of first strong flow, and the permeability of each pit by a recuperation test, it might be thought we had only to place our drains along a line of high coefficients and at first strong flow level to effect full drainage. Unfortunately this is not the case as is exemplified in one part of the Baramati experimental area. There, a drain placed along a line of high coefficients and at first strong flow level, has had a most disappointing effect, water standing 4 feet higher than the drain at a distance of only 20 feet. Our drain has in fact merely drained off the local water, and has had practically no effect on the deep subsoil pressure which appears to be mainly developed along fissures.

This is a very extreme case, in what was the worst affected area on the whole Nira Left Bank Canal ; but many of the worst areas are modifications of this extreme type. In this area we have struck one fissure which gives a discharge of ¼ cusec, which is more than the discharge of all the drains, which total nearly a mile in length, put together.

In many cases, however, high coefficients are an excellent guide and almost always give valuable information, but they have not provided a full simple solution for all cases. In other words, it is not

always sufficient merely to trace local permeable strata; we must also trace the natural deep subsoil flow before we can hope to make drainage fully effective at a minimum cost.

The fact that we have to deal with a pressure is what has to be grasped, and is what makes the problem so very difficult.

You cannot skim off the top water so to speak for the pressure still remains, transmitted through the permeable layer at a great depth and very probably through local fissures. For this reason intercepting drains have been a complete failure, the subsoil water level and pressure rising abruptly immediately below the drain. This is because we have only cut through a moderately permeable upper layer, in which the pressure is merely diffused. It is, in fact, on a parallel with trying to reduce the pressure in a water main by opening a tap in a house. Unless you can strike the main, or at least submain, you cannot appreciably affect the pressure. Another alternative would be to open hundreds of taps, *i.e.*, to open numerous small drains, but in land drainage this would be excessively costly and cannot compare with finding the main natural drainage, if that be possible.

Our first work, therefore, consists in opening out the natural deep drainages, or the original *nalas* of the denuded valley.

Recommendations have been made from time to time to reopen the existing *nalas* which have silted since the canal was opened, and where the original *nalas* and depressions were along the natural drainage lines this is what must be done. What we have found, however, is that the *nalas* very frequently do not follow the natural drainages, and that the depressions or subsidiary *nalas* seldom do. They are, in fact, nothing more than secondary superficial drainages. Besides, where they do follow the natural drainage little damage has occurred. Where the damage occurs is where the natural drainage line has been filled up with silt, and a new surface drain bearing no relation to the natural drainage has been superficially scoured.

In the canal area, many of these drainages have been opened by the irrigators along the line at which *murum* dips below the impermeable subsoil layer (*i.e.*, at the point at which the subsoil water finds an easy outlet before becoming imprisoned under the

deep *chopan* layer), while many of the partly silted natural drainages have been completely blocked by banks and levelling. Where this has been done the land is rapidly ruined, and the energy and money expended worse than wasted.

In other places the superficial trenches so far from acting as drains merely collect water, and at lower levels they act as supply channels adding to the damage instead of reducing it.

The main work to be done, therefore, is to trace the deep natural drainages, and open them out where possible. Where on account of the permeable layer being at a very great depth, as is frequently the case in the Godavari valley, all perennial irrigation must be stopped and the canal lined.

Subsidiary drainage will be comparatively simple, though costly and this again will have to follow the natural subsidiary drainages

Where the permeable layer is at such a depth that a drain reaching down to it is out of the question, much can still be done by driving down bore holes into this stratum, when the water rises under pressure and can be carried away by a comparatively shallow pipe drain at about 6 feet. The main difficulty about this is that the greater the depth, the greater the cost of tracing the natural drainage.

Where free drainage is prevented, and water rises to within 3 to 4 feet of the surface, damage is likely to occur. The seriousness of conditions will, therefore, be realized when it is stated that at least two-thirds of the area suitable for sugarcane in the Nira Left Bank Canal perennial section has water within this dangerous limit and in many cases salt is merely kept down by constant heavy irrigation.

THE PREVENTION OF SOIL EROSION ON TEA ESTATES IN SOUTHERN INDIA.*

BY

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At the meeting of the Board of Agriculture in India held at Pusa in 1916, the subject of soil erosion was discussed, and it was resolved to bring to the notice of planters the fact that the serious losses due to soil erosion in the planting districts, which have taken place in the past, are to a large extent preventible.[1]

Dr. Hope, of the Indian Tea Association, has published an interesting account of the methods adopted in Java, by means of terraces, to prevent loss of valuable top soil in the tea districts.[2] Here, however, the terracing is done on new land when it is opened and before the tea is planted. The problem presented on many estates in South India is how to stop soil erosion in old established tea, and a good deal of work has been done in several districts during the last few years with the object of solving this problem in a practical and economic manner.

Two methods have been adopted with success. The first is a modification of the terracing work done in Java. At the time of pruning, trenches are opened along the contours of the slopes at intervals of four or five rows of tea bushes. These trenches are put in with a road tracer and made 18 inches to 2 feet deep, and in

* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

[1] *Proceedings of the Board of Agriculture in India held at Pusa on 7th Feb. 1916, and following days*, p. 34.

[2] Loc. cit., p. 75.

them the tea prunings are buried, the upper layer of prunings being packed so that the butts project from the ground level when the trench is filled up some 6 or 8 inches. The soil in the intervening rows of tea is then forked and manured, if necessary, and in some cases a green dressing crop is sown on it. The fence of buried prunings serves to catch any soil which is washed down from above and retain it. Unfortunately the tea has in nearly all cases been planted in such a way that the lines run up and down the hill, and not along the contours, but it is possible to arrange for the estate work, plucking and weeding, to be done along the contours, and this gradually helps to form natural terraces where the prunings have been buried. At the next pruning season, some three or four years later in our case, the terraces are repaired and improved, and new ones made in the same way. This method has been found to stop soil erosion to a very marked extent, and it is coming much into favour on moderately steep slopes.

The second method used is to abandon forking and clean weeding on very steep slopes, and to keep the soil covered all the time by some selected weed. This method of dealing with steep slopes has of course met with a great deal of opposition from the clean weeding school; but in Southern India at any rate, I am happy to say, the fetish of clean weeding is rapidly becoming obsolete. The choice of evils lying between keeping a cover of weeds on steep slopes and allowing them to be washed by the heavy monsoon rains is largely in favour of the weeds. The utmost harm that the weeds can do is to absorb moisture in the dry weather from which the tea suffers a little, but this cannot compare with the harm done by the constant loss of valuable top soil, which goes on from slopes kept clean and forked. Any plant food which the weeds take up from the soil is ultimately returned to it again as the weeds rot down, and returned in an available form, while if the weeds are leguminous there is a steady accumulation of nitrogen.

It is sometimes thought that forking prevents soil erosion, but this is far from being the case. In the process a considerable quantity of soil rolls down the slopes on to the roads, however carefully the work may be done, and much of this is carried away by

the first heavy rains. Experiments carried out in Ceylon showed that the erosion from a forked surface was more than from a similar surface kept clean-weeded. The loss of soil from a clean weeded surface during a certain time was 814 lb., while that from a similar surface in the same time which had received a plain deep forking was 1,393 lb.

The method adopted is to establish some particular weed by means of selective weeding that is to say, the weeding coolies are taught to leave the particular weed chosen and remove all others by hand. In this way a cover of a particular plant is soon established on the steep slopes, and this is kept *in situ* all the time, the utmost that is done to it is to sickle it and clear it out from round the bases of the tea bushes. In this way soil erosion has been almost entirely prevented even on the steepest of banks, and in the heavy rains the run-off is clear instead of being laden with silt. Moreover, the weeds accumulate humus and add by their decomposition a valuable surface layer to the soil which is retained.

A number of weeds are being used for the purpose. The ideal plant is a leguminous one, which will accumulate nitrogen, a plant which does not either climb into the tea bushes, or make too thick a mat on the ground, and one which grows only a few inches high. Such a plant is hard to find, and the one which most nearly matches the ideal is *Cassia mimosoides*, L. This plant, at elevations of 4,000 feet and over, has a short habit of growth, branching and spreading out at the base. Its feathery semi-sensitive foliage allows the rain and sun to reach the soil, while at the same time protecting it from erosion. It is fairly easily established and it seeds freely. On many estates it forms a thick cover and has been found a most useful green dressing and soil preserver.

Another leguminous weed of which use has been made is *Parochetus communis*, Hamil., a plant with a clover-like habit but it is not easy to establish over big areas and its life is not long: it dies down to the creeping rhizome in the hot weather.

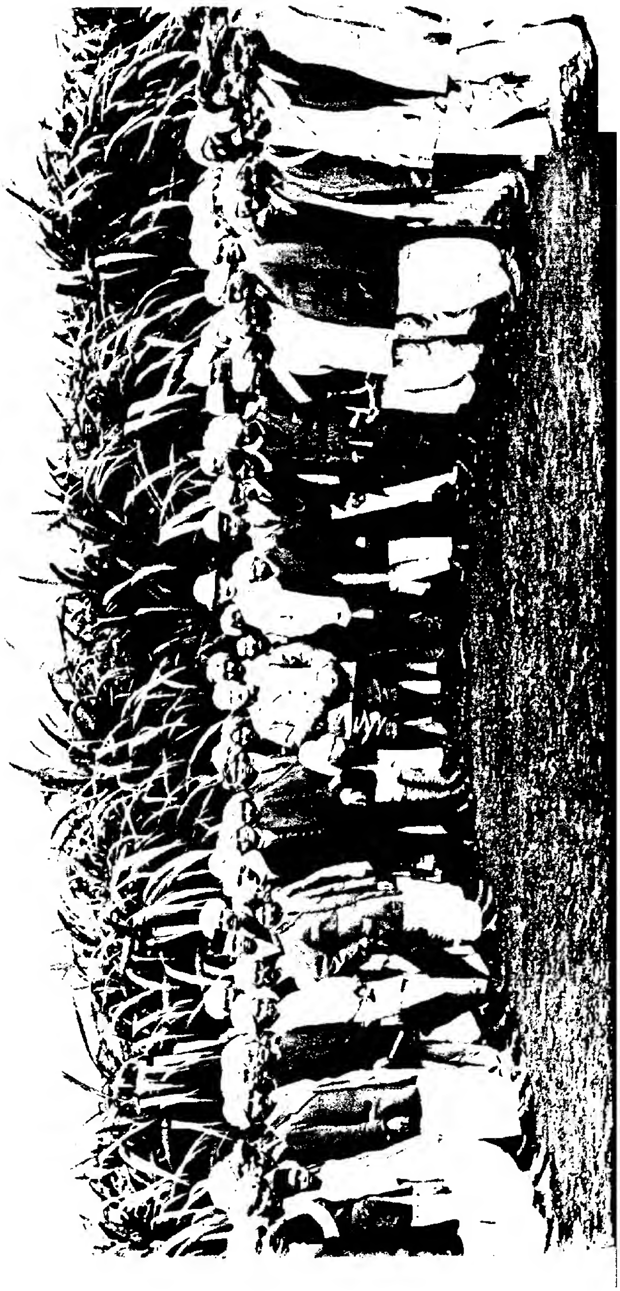
When a suitable leguminous plant cannot be found or easily established, advantage is taken of the presence of other weeds, and these are encouraged and established. Among these may be

mentioned *Oxalis corniculata*, L., which is very easily established and which forms a dense short cover easily controlled. Many hundreds of acres of steep land are now under this weed, and the tea has decidedly benefited and the soil erosion under *Oxalis* is practically nil. No harm whatever has been done to the tea; yields have been maintained and in fact have increased, and in the hot weather the effect on the tea is very slight.

Any weed has been considered better than none at all on steep slopes, and when the above-mentioned cannot be established, use has been made of the following plants, either by themselves or mixed: *Cotula australis*, Hork.; *Cardamine hirsuta*, L.; *Galinsoga parviflora*, Cav.; and *Laurenberghia hirsuta*, W. & A.

The intelligent use of weeds has gone far to overcome a form of soil erosion which has in the past caused a great loss of soil and done a lot of damage in some parts of the tea districts of Travancore. Here the land is very steep and the soil is of such a loose texture that in the dry weather the angle of repose may be exceeded, and at the least touch the top soil comes sliding down. Wind even sets it moving and the plucking coolies passing through the fields send the soil tumbling down the slopes on to the roads. The loss of surface soil in such places has been enormous and very rapid, and the ridges are in some places almost entirely denuded of surface soil.

On such soils the maintenance of a permanent crop of selected weeds has gone far to stop this loss and solve the soil erosion problem, which has always been recognized by the planters as a serious and important one.



FURTHER EXPERIMENTS AND IMPROVEMENTS IN THE METHOD OF PLANTING SUGAR-CANE AND FURTHER STUDY OF THE POSITION OF SEED IN THE GROUND WHILE PLANTING.*

BY

M. L. KULKARNI,

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As promised in the concluding portion of my preliminary paper,[1] read at the last meeting of this Congress held at Lahore, on the single eye-bud method of planting sugarcane with the eye-bud placed upwards, I give to-day the results of outturn as obtained by that method, and compare them with other improved methods. As stated in last year's paper, the comparative experiments were tried on the Dharwar Farm which is not quite a typical place for sugarcane. Here, owing to the peculiar conditions of soil and water, the Brix reading of the cane never went above 14 per cent. in the different methods of cultivation. Hence, in comparing the outturns, only the weight of cane is taken and not the *gur* (crude sugar).

* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

[1] *The Agricultural Journal of India*, Special Indian Science Congress Number, 1918, p. 125.

The following is the statement of outturn of sugarcane under the two methods of planting :—

Number	Method of planting	Area in *gunthas* *	Number of eyes planted	Number of plants germinated after 20 days of planting	Percentage of germination	Number of plants finally kept, including mother and tiller plants	Number of canes harvested	Weight of cane harvested	REMARKS
								lb.	
1	Single eye-bud, point upwards.	1	901	833	82	1,[illegible]79	843	4,325	
2	Three eye-buds, points sideways.	1	1,002	511	50	889	782	3,366	

* One *guntha* = $\frac{1}{40}$th of an acre.

Number	Method of planting	Number of eyes planted	Number of plants germinated	Percentage of germination	Number of plants finally kept, including mother and tiller plants	Number of canes harvested	Weight of canes harvested	Average weight of cane	REMARKS
							lb.	lb.	
1	Single eye-bud, point upwards.	27,030	24,990	82	32,370	25,290	129,750	5·1	57·8 tons.
2	Three eye buds, points sideways.	30,060	15,330	50	26,670	23,460	100,980	4·3	

The Brix reading in both the methods, as said above, was only 14·2. With this reading, the outturn of *gur* obtained was in –

		lb.
(1)	Single eye-bud, point upwards	12,570
(2)	Three eye-buds, points sideways	9,660

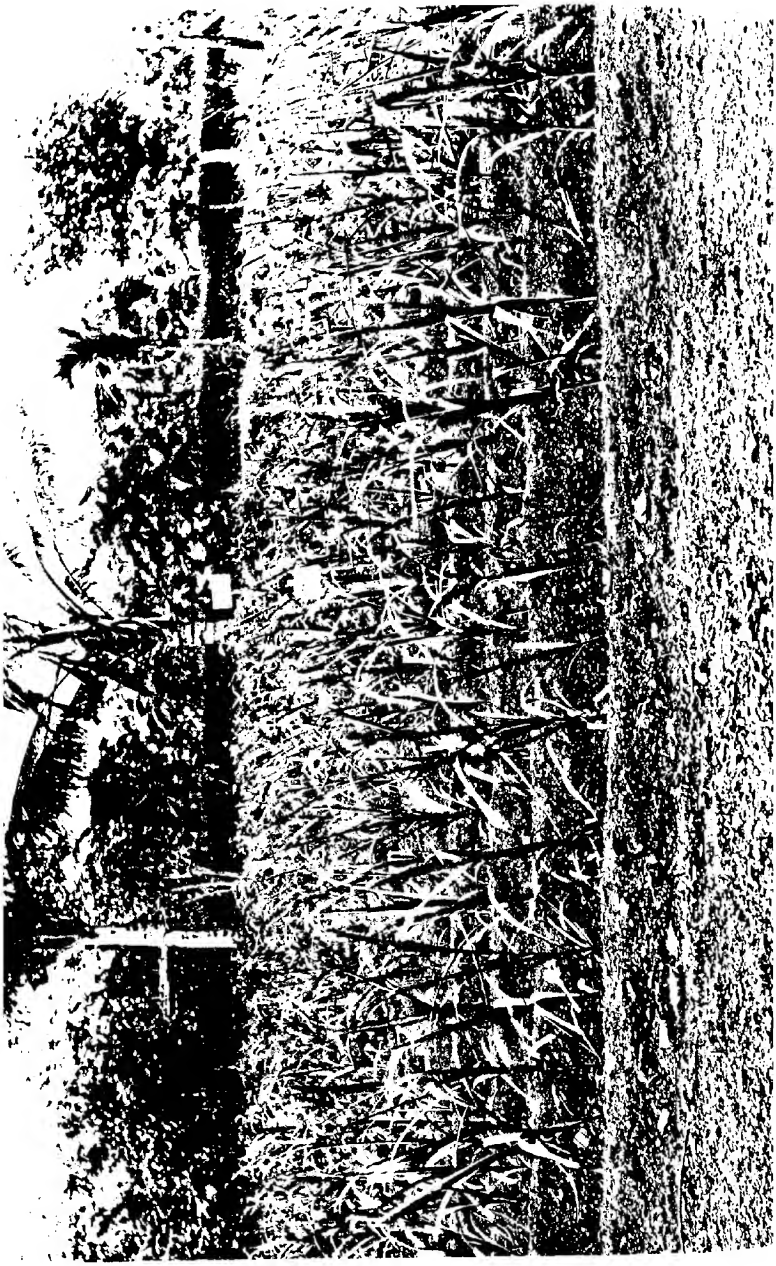
Had the Brix been 18 or 19 per cent., as in the typical sugarcane tracts, the yield of *gur* would have been—

		lb.
(1)	Single eye-bud, point upwards	16,350
(2)	Three eye-buds, points sideways	12,725

Setts with two eyes up. Setts with three eyes side. Setts with single eye up.

Sugarcane rows during the first month.

Sugarcane rows after a dose of ammonium sulphate was given as a top-dressing.



From the above statement it will be seen that, in the case of single-eye-bud planting with the point upwards, the yield of canes has been about 25 per cent. more. This higher outturn is partly due to the position of eyes while planting the setts, and partly to the removal of tillers as previously described.

Plate XXVIII is a view of last year's cane crop with single eye-bud (point upwards) at the time of harvest.

Further experiments on a larger scale are being carried out on the Canal Farm at Gokak.

There are, however, certain disadvantages in the method described above. The sett being too small and exposed on both sides close to the bud, the plants developed from these buds, though quicker in germination than the side-bud planting, look somewhat unhealthy during the first month till a small dose of ammonium sulphate is given as a top-dressing, as will be seen in Plate XXIX, fig. 1. When the top-dressing is given, the crop, though weak before, begins to grow as luxuriantly as crops under other methods. (Plate XXIX, fig. 2.)

A further improvement was made in the method of planting. Setts with three eyes were taken, as is the usual practice, and the middle eye was removed by a knife; the sett was then placed with the remaining two eyes upwards.

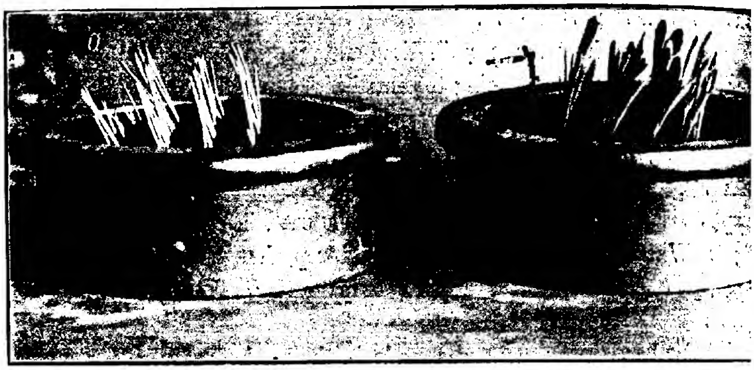
Plate XXX shows the side view of the resulting crop in its early stage.

To get the maximum number of canes in the method of "two eyes up," the setts are planted at $2\frac{1}{2}'$ to $3'$ apart, and the distance between two setts is about $6''$. This gives about 25,000 canes per acre at harvest time. It is expected that the yield of the two-eyes-up method will be better than that of the single-eye-up of last year, the former removing the defect of the small exposed sett and retaining the advantage of position of seed. The results will be available next year.

As stated in last year's paper, the uniform crop of cane obtained by the single-eye-bud method with all the eyes placed upwards suggested, with regard to the cause of unevenness in the plants in ordinarily sown field crops and the non-germination even of some

of the good seeds, that these differences may be partly due to the position in which the seeds fall in the ground while sowing. Accordingly, last year, further tests of different kinds of seeds in different positions were made.

In the case of maize, seeds planted with the points upwards germinated last, and produced weak seedlings; while seeds planted with the points downwards and sideways produced healthier plants.



Point up-down-side-side.

Point side-side-down-up.

Pot test with maize seed.

Field tests made this year on leguminous crops (*viz.*, sann-hemp jack beans) and cotton, show that the plants produced from seeds planted with the points downwards or sideways are better than those coming from seeds with the points upwards. The results obtained in all these crops are uniform. (Plate XXXI.)

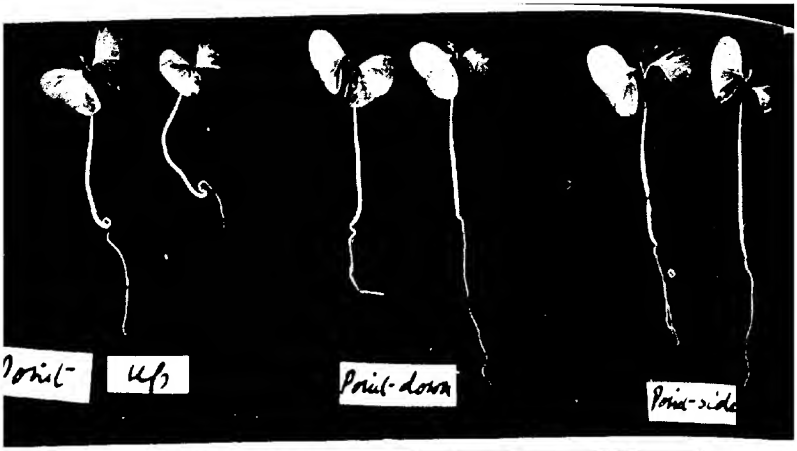
The observations made in the field experiments carried on during the current year, where seeds naturally fall deeper in the ground than in pots, showed that, as in the case of cotton described last year, the seed coat was freed in certain plants from the plumule, before appearing above ground, by the weight of the soil through which it had to force itself up. However, great variations were seen in the young plants in a field crop, some germinating early with healthy cotyledons and some coming up late with sickly seedlings though sown at the same time and under similar conditions. This induced

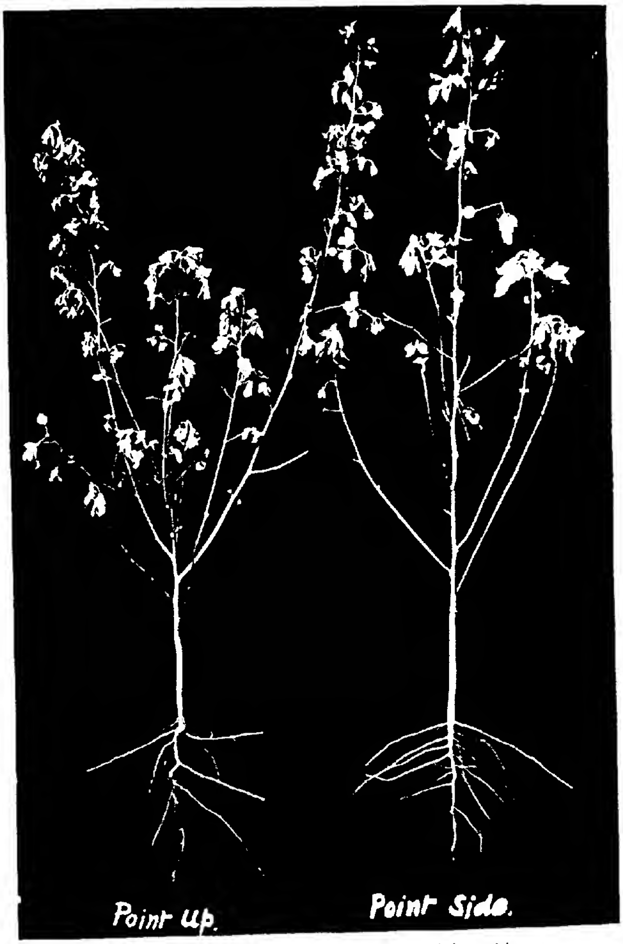
...nt up — Point down. — Point side.

Sann-hemp.

...nt up. — Point down. — Point side.

Kumpta cotton, bushy type (Gokak Farm).





Radicle bent

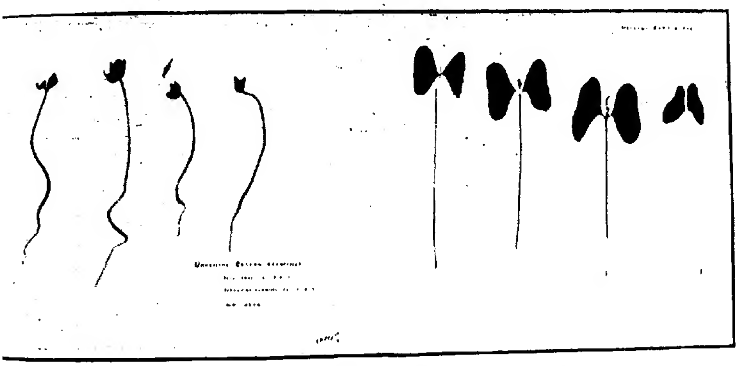
Radicle straight.

Root systems of cotton plants with different positions of seed.

the writer to examine carefully both the healthy and weak plants, and it was found that, in the case of healthy plants, the radicle and the plumule form a straight line, the former going straight down and the latter coming straight up. In the weak and late seedlings radicle and plumule go in zigzag ways.

This is partly due to the improper position of the seed in the ground, and partly due to the weight of the soil over and pressure by the side which may interfere with the seedlings. Thus the plants which receive a check in some way or other while germinating remain weak for ever and their growth is further checked by the neighbouring plants which make a healthy start from the beginning.

The following photograph gives an idea of the root system of the healthy and weak seedlings of cotton in their early stage.



Unhealthy and healthy cotton plants from a plot ordinarily sown.

To know exactly the root system of cotton plants coming from different positions of seed, a test was made in pots, and the plants with their root systems are shown in Plate XXXII.

The root system of the seedlings, and the consequent healthy or weak appearance of the cotyledons, suggests that the unevenness of plants in crops in which seedlings are transplanted, such as chillies, brinjals, tobacco and many other vegetables and fruit trees, may be due to the improper position in which the roots are placed

in the ground while transplanting. Similarly, the unevenness in the growth of several of our cultivated fruit and other trees, and the naturally-grown timber and other forest trees, may be due to the different positions of seeds in which they are planted or fall of themselves.

Experiments on these points seem necessary.

CONCLUSIONS.

(*a*) The position of seed while sowing or planting is one among many other causes by which unevenness in plants is produced in ordinarily sown field crops, and also of the occurrence of non-germination of even some of the good seeds.

(*b*) It is possible to put the seeds in a proper position in such crops only, whose seeds or setts are dibbled or planted by hand.

(*c*) In the case of sugarcane, an absolutely uniform crop can be obtained by planting the setts with eyes upwards and by the removal of tillers.

Selected Articles

CO-OPERATIVE MARKETING.*

BY

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In a country so predominantly agricultural as India, the most vital question is not for which crops the climate and soil are most suitable, but which crops will yield the highest net return to the cultivator. The answer to the first question is to be found in the science of modern agriculture, and different agricultural departments throughout the country are trying to discover it. The second question is a problem in practical rural economics and there is as yet no school of practical rural economics in India. When communications were ill-developed and the prime object of the cultivator was to grow food for himself and his family, and a surplus to meet their other needs, marketing was simple. The surplus was sold to the nearest buyer who paid probably the least he thought the seller would take. As communications have improved, the cultivators have become less dependent upon the local market, and it has become possible to grow tea, coffee, jute, groundnuts, and cotton for export. Where this is the case there is a tendency either towards the capitalization of agriculture, as exemplified by the big tea estates, or towards dependence upon powerful middlemen. The individual cultivator is not in a position to study the requirements of distant

* Reproduced from the *Bombay Co-operative Quarterly*, March 1919.

markets, and his own output is too small to permit of his embarking on commercial transactions. So long as he grows staple crops, he can without much difficulty secure something approaching a fair price. Wheat, for instance, being a world crop, its price is determined at the big secondary markets, of which Liverpool is the most important. Buyers in India can calculate easily the highest price they can offer so as to leave a margin of profit, and competition secures to the producer something not far removed from this. Where, however, the crop is a specialty, namely, one for which there is no regular market quotation, the producer is at the mercy of the middleman. If the specialty be not rapidly perishable, the producer may be able to hold out for a good price; if it be perishable, such as fruit, vegetables, etc., he is practically helpless, single-handed. The production of specialties is thus dependent on the system of marketing, and it is probably defective organization for marketing that accounts, in part, for the small outturn of high paying specialties and the devotion of so large an area to less paying staple crops, such as wheat.

Speaking very generally, Indian agriculturists are poor because they are trying to maintain by extensive cultivation a population more than sufficient for the most intensive system; as Professor Slater has pointed out, the rural worker is unemployed for a large portion of the time. In England, one man may look after a farm of 70 acres, and three would work one of 125. In this country, there would probably be from four to nine on the first, and ten or twelve on the second. In dealing with Indian problems, it is unwise to generalize, and in dealing with questions of Indian poverty it is impossible to account for all the facts by a few causes; but there are grounds for believing that unless the excess rural population can be occupied in industries, the hope for agricultural prosperity must lie in the evolution of a highly intensive system of cultivation which will fully employ and fully repay all the labour available. If the outturn of the present kinds of crops in the Punjab were raised to the English average, it could not suffice to feed the people on the English scale. The land, in short, under the present crops will not support the people under an improved dietary. The problem of

raising the standard of food is thus not so much one of improving the outturn of existing crops, as of evolving a satisfactory system of intensive agriculture and of selecting crops that will respond to this method. Thus both producer and consumer are intimately concerned in the question of growing specialities, and as the growth of specialties is largely dependent on the system of marketing, the latter problem is deserving of wide attention and [illegible]. Now, as Mr. Keatinge has pointed out in his "Rural Economy in the Bombay Deccan," "the marketing organization is very defective and we can only look to the co-operative spirit." Where prices are indefinite, the cultivator requires an organization to protect his interests and to secure for him all the advantages his crops can earn; and whatever a cultivator requires in the way of organization the co-operative method can usually best supply.

Co-operative marketing requires more careful organization and more expert guidance than the more simple forms of co-operative activity, such as supply and credit; it calls for more discipline amongst the members and not infrequently for a considerable outlay of capital. To ensure success, careful preliminary study is required, and, accordingly, a work which describes in much detail one of the best known examples of co-operative organization for marketing is most welcome. In his "Co-operative Marketing,"[1] Mr. Cumberland has successfully attempted to draw an accurate picture of the actual operations of the series of organizations that form the distributing system of the California citrus-growers. The subject has already been dealt with in somewhat less detail in Mr. Powell's "Co-operation in Agriculture," but there is room for this more elaborate account, in view of the vast importance of creating a comprehensive system of distribution that shall be at once efficient and cheap. When the public buys food it is paying the middlemen and retailers as much to supply it as it is paying the cultivators to produce it; the consumer gets too little for his money and cannot afford to buy more. Demand is thus restricted and greater supply is discouraged. There

[1] "Co-operative Marketing," by W. W. Cumberland, Ph.D., Assistant Professor of Economics, University of Minnesota.

is at present much grumbling against high prices which should be directed against high charges for distribution. The expression "high profits" is avoided, as it is doubtful if the Indian middlemen get such profits as some people think, owing to their defective methods and lack of proper organization. Somehow, the sight of an Indian middleman or retailer poring over books on marketing or studying prices in different towns and the cost of sending goods there is not common. The average member of this class could not read the books or understand the railway tariff, and his educated son becomes a pleader instead of an expert distributer. Marketing efficiency requires specialized skill, extensive information, and wide knowledge. The expert potato-grower, the owner of a fruit garden, or the industrious market-gardener around the big towns is usually profoundly ignorant of the general market situation. If he wants to know the price of a thing he will enquire from some one seeking to buy or from a friend who has just sold; if he were told that he could get a better price at some distant town he would not know how to dispose of his crops there. He pours his produce into the nearest market which for him is not unseldom the worst. Of the advantages of warehousing, storage for a better price, preservation to last over a glut, etc., he knows but little. Of grading in order to secure a higher price for better produce he has little idea. The result is all round inferiority and waste. A cultivator is not likely to expend much effort on growing finer vegetables or better fruit, or on breeding a higher class of poultry, unless he is reasonably assured of an extra reward over and above what his less enterprising neighbour receives. In the Punjab, there was at first considerable difficulty experienced in getting a higher price for long staple American cotton. The Agricultural Department first started the auction system, and now co-operative sale societies are being formed to hold auctions. At the first co-operative sales held this season, the staff graded the cotton under the guidance of agricultural experts and the resulting classes were auctioned separately, and the prices obtained varied with the purity of the cotton. The result is that cultivators are prepared to uproot from their fields any *desi* cotton plants that have got mixed up with the American variety. Until the American type obtained a higher

price than the old short staple variety, cultivators hesitated to grow it; now the difficulty is to supply sufficient pure seed to meet the demand.

The lack of proper marketing organization may again be illustrated by reference to Punjab oranges. The province grows a fine orange known as "malta," but there is no attempt to place it on the market on a modern system. There is no grading, and hence there is no inducement to the growers to look after their trees, prune and manure them, and improve the fruit. There is little attempt to find a wider market, and hence the production is far smaller than it should be. The garden-owners usually sell the crop on the trees to a contractor and seem quite satisfied with the price. There is practically no attempt to store, though the orange being hard-skinned keeps well, and the whole produce is thrown into the towns as it ripens. What the industry might develop into, if thoroughly well organized on the lines of the California Cotton Growers Association, can only be guessed. One very important advantage to be obtained from an efficient system of co-operative marketing is the reconciliation of the two factors mentioned at the beginning of this article. For the crop for which the climate and soil are most suitable will tend to pay the cultivator the highest return if he can secure a full price of it. The adoption of business principles in agriculture will relieve the cultivator of the necessity of growing food for his family on soil that is better adapted to something else. He will be able to concentrate on the most profitable crop and to buy his food from lands better adapted to grow it. In a country of small holdings this is of great importance. The average Punjab peasant is poor on eight acres, the Californian fruit-grower is prosperous on fifteen. The former grows a variety of crops, some to eat, some to sell, some for his cattle, and some, like hemp, for the needs of his industry. He is expert in the growing of none. The expert fruit-grower can develop a high technical skill. The problems of irrigation, cultivation, fertilization, protection from pests, eradication of disease, etc., of a single crop are many, but they are less numerous than the same problems for a series of crops, so that while only the most highly trained may hope to cope with the latter, a good intelligent

cultivator should be able to acquire a sound practical knowledge of the former. High technical skill warrants the investment of considerable capital, and the cost of cultivating an acre of oranges varies from Rs. 260 to Rs. 600 a year. Obviously, with so much at stake and so much to recover, the problem of sale is of far greater importance than it is in the case of a staple crop of which the current price in the chief markets is always easily ascertainable. The price of wheat being more or less fixed by factors independent of the cultivator, the latter has to seek increased profit by increasing his production without an equal increase in cost. But in the case of a specialty the price obtained is largely dependent on the methods of marketing. If the middlemen will serve the producer honestly and well, the latter is not likely to combine, but experience shows that if the producer desires to be served honestly and well he must serve himself, in other words, he must co-operate, and if he once decides to co-operate, he will gradually gain all the advantages which large-scale efficient organization can give. Of the form of the organization that has grown up in California it is unnecessary to give details. It follows closely co-operative principles as practised elsewhere. The 'one man one vote' rule is modified to meet the circumstance that one man may have a five-acre orchard and another one of 100 acres, and votes vary with the acreage under fruit. Further, membership goes with the orchard and not with its owner. Thus a member who sells his orchard ceases to be a member. The object is to serve the growers at the actual cost of the service, and no profits are sought to be made; the "dividend malady" is thus avoided.

The actual results of the co-operative organization have been remarkable. The cost of packing has been reduced so that something approaching ten crores of rupees has been saved to the producer in twelve years; by the exercise of organized bargaining, railway rates have been reduced, resulting in a saving of fifty lakhs of rupees a year; commission on sales has been reduced from 7 or 10 per cent. to the actual cost of 3 per cent.; losses from failure to recover the sale money have been eliminated. Where the individual grower is unable to afford the time, trouble, and expense involved

in presenting a claim for damage in transit against a railway or transport company, the big organization does it for him with ease and success, and railway servants have learned in consequence to handle the goods with greater care. A further great advantage has resulted from the considerable improvement in cultural skill which the organization has encouraged. It has been possible to secure expert investigation into the various difficulties and to make the results known to the growers; great success has been attained in eliminating waste due to delay; the causes being discovered, the members have been enjoined to avoid the mistakes responsible for this source of loss. The biggest task was to find new markets to permit of enhanced production and to supply them so as to secure a good price without frightening the consumer: this was in some ways the most difficult of all, but careful study and collection of information solved it. For detailed descriptions of the methods adopted to secure these results, the reader is referred to Dr. Cumberland's book. The essential element is organization on co-operative lines, and no one acquainted with conditions in this country will be prepared to doubt that extremely valuable results await well-directed effort here. The field is immense, but comparatively speaking it is empty of workers. The commercial and trading classes show little capacity for organization. Their methods are as backward in their own business as are those of the cultivator in his. We have thousands of pleaders, but no expert market organizer, hundreds of books on Indian law, but hardly a dozen of any merit on rural economics. We are told that fathers can find no employment for their graduate sons, while numerous factors producing poverty and disease lie around neglected. To all with the leisure to read and the desire to help India, we can commend Dr. Cumberland's "Co-operative Marketing" as a study in the practical promotion of prosperity by methods open to all.

ECONOMIC CONDITIONS IN SOME DECCAN CANAL AREAS.*

BY

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THE canal areas in the Deccan have features of intense importance to co-operators in Western India as well as to all others who have an interest in the economic development of the country. Some of these, so far as I can judge, are unexpected, but the possibility of their being repeated in future similar conditions makes their study worth while at the present moment.

The greater irrigation canals of the Deccan are four, and their relative characters are as follows. I have, in each case, in order to compare the size, indicated the area of "four months' crops" which they are calculated to be able to support :—

(1) The Gokak Canal, which cost 19 lakhs of rupees, and is capable of giving water for 10,000 acres of four months' crops.

(2) The Mutha Canal, opened in 1873–78, which cost 115 lakhs of rupees, and is capable of giving water for 49,000 acres of four months' crops. (As this canal also provides the water-supply for Poona, neither the cost nor the area is comparable with the others.)

(3) The Nira Canal, opened in 1884, costing 99 lakhs of rupees, and capable of irrigating about 100,000 acres of four months' crops.

(4) The Godavari Canal, recently opened, and capable of irrigating about 57,000 acres of four months' crops.

* Reproduced from the *Poona Agricultural College Magazine*, April 1919.

All these lie in tracts of very small and variable rainfall, most of the character of the rain coming, when it does come, in heavy storms of short duration. Except for the Gokak area the rainfall varies from twelve inches upto about twenty five inches per annum, but is generally under twenty inches over the [illegible] of the area. As a result of the rainfall, the hill-tops [illegible] lands, as well as the upper portions of the slopes are usually washed almost free of any fine soil, and hence there are on these positions very shallow stony lands. The drainage channels are deep and highly scoured. On the other hand, however, the valleys are filled with soil of good quality, whose depth largely depends on the narrowness and steepness of the valley as a whole. Previous to the advent of the canals, the wells were usually deep, and irrigation, while it existed in favoured areas, was comparatively uncommon. We have, therefore, in these areas, tracts of country, which before the construction of the canals were famine-stricken and poor, where a fairly good crop could be looked for certainly not more than one year in three, where the ordinary dry crops of the Deccan were grown, where labour was superabundant and went outside to find work, where land was cheap and manure (as in all dry-crop areas in the Deccan) little used, where the villages were small and poverty-stricken but fairly healthy, and where little capital or credit existed.

These remarks apply to all the tracts in question. In what follows, however, I am going to speak more particularly of the area covered by the Nira canal, which was not only one of the earlier canals, but was brought to a country where irrigation was a new thing, and where it has now existed long enough to enable us to judge of its economic effect. I know this valley well, and I can speak largely from my own knowledge and experience, while to co-operators it has a special interest as it has been, and is, a special field for the activity of the Bombay Central Co-operative Bank. In the year 1884, the Nira canal was opened, and the effect on the district which is covered was almost immediate. I have calculated the figures for the area under sugarcane and under gardens, and also the area carrying two crops a year in the Bhimthadi Taluka (where the greater

part of the Nira canal area is situated) at various times, and they are as follows :—

	Area under sugarcane	Area under garden crops	Area double-cropped
	Acres	Acres	Acres
1885-86	445	999	7,981
1890-91	675	2,656	14,461
1895-96	2,690	1,423	8,165
1901-02 *	5,823	2,346	19,975
1905-06	5,203	1,820	16,665
1910-11	6,229	1,246	9,626

* I have taken this year instead of 1900-01, as the latter was the year of one of the most severe famines in the Deccan, and this rather vitiates comparison with it.

The effect of the introduction of the canal on the agriculture of the area was not, in the first place, a very large increase in the amount of sugarcane, but rather an increase in the crops the people had been usually growing, like vegetables, and a larger use of double-cropping. In other words, it was a continuance of previous practice, though on a more intensive scale. But little by little it became evident that sugarcane was capable of yielding, under irrigation, greater returns than such garden crops or than such double-cropping, and very gradually the amount of sugarcane increased. This was partly due to the enterprise of the people themselves, but also, in a considerable measure, to the incoming of a group of cultivators—the Saswad *malis*—who rented the land without any idea of purchasing it, but who were expert sugarcane growers and who knew how to make large amounts of money by it.

It will be seen, however, that from a tract of intensive cultivation, the Nira valley canal area tended to become a land of one crop. Garden cultivation has declined, and the double-cropped area is now little greater than before the advent of the canal. That one crop, however, was an exceedingly valuable one and, when well cultivated, gave very large returns. Hence, the land capable of being irrigated and of growing sugarcane rose rapidly almost to ten times its former value. Areas, formerly saleable for Rs. 50 to

Rs. 100 per acre, became worth from Rs. 500 to Rs. 800, and the result was an enormous expansion of credit.

This very large increase of credit was, however, fully needed. Intensive cultivation of whatever kind leads to a very large demand for money. In the present case the demand was extreme, for, as grown in the Deccan, sugarcane needs more floating capital per acre than almost any crop that I know. A man is considered to be unwise who spends less than Rs. 500 per acre on a single year's crop. This demand for money, accompanying the rapid rise in the price of land, caused a large number of financiers or money-lenders, who usually follow closely the growth of high-class crops, to settle in the district. It will be seen that the presence of such financiers was necessary, but, as usual, when advancing money on a crop, they have charged a very high rate of interest, and bargained to act as brokers for the sale of the *gur* or *jaggery* from the cane. The usual rate of interest in the Nira valley for advances on the cane crop has been 18 per cent., the usual brokerage rate for selling the produce, I am informed, has been 8·6 per cent.

If I may digress a little, I should like to call attention to two other indirect economic results of the bringing of canal water into the Nira canal area. The first is that it allows much greater subdivision of the ownership of the land to take place than would otherwise occur. Subdivision, to an excessive extent, is at present one of the great banes of Deccan agriculture. But subdivision in practice, if not in theory, must stop when the areas owned are not worth owning. By increasing the value of the land you can make the subdivision of ownership much greater than it was before. The second indirect result has been the creation of a feeling that actually to work on one's holding is rather beneath the dignity of a landholder, and while, before the appearance of the canal, nearly all cultivators would plough and cultivate their own land, it is now usual for almost all but the very small growers of sugarcane to carry on nearly all agricultural operations by means of labourers. There is, therefore, a greater and greater tendency to depend on labour.

These matters are, however, by the way. The general progress was as follows :—Sugarcane cultivation was found to be capable

of giving very high returns. This led to very largely increased land values, and hence to greatly expanded credit. This, again, led to the greater concentration of effort on the one crop, namely, sugarcane, which was able to give the highest returns.

Now, dependence on one crop is always a risky thing. It is risky because the variations in price of a single article (in this case, *gur* or *jaggery*) may be so great as to destroy a large part of the profit, and the crop, in this case, is on the land so long that there is little chance of a change in price being foreseen. It is also risky because a single crop is always liable to be attacked with disease or destroyed by unfavourable weather conditions, and, finally, it is risky because land is always liable to deteriorate when grown continuously or frequently to one particular crop. These risks may perhaps be faced with equanimity if a man is using his own capital, but if he is paying over 20 per cent. (including the brokerage) per annum for the capital he is employing, and if, in addition, the capital required is very great indeed, the risky nature of the cultivation is much emphasized.

In the present instance, the price has proved much more constant than might have been expected, though there was a time, about ten years ago, when it fell almost to the cost of production. The crop also has been, on the whole, very reliable, and the diseases which have ruined the crop in many other places have not done fatal damage in the Nira valley. The land has, however, in many places deteriorated badly, and this deterioration is, if my information is correct, still going on.

In an area of arid land, brought under irrigation, there is always a tendency for an accumulation of salt to take place on the surface of the land, unless drainage is particularly good. And this is particularly the case if the irrigation is intensive, and if the subsoil, formerly dry, becomes filled up with seepage from the canal or from the irrigated fields. Now, with the increase of sugarcane cultivation, the irrigation became more and more intensive, little attention was paid to drainage either by the canal authorities or by the people, the subsoil became more and more filled with water, and the land became more and more injuriously affected by salt. In many cases.

the salt increased so much tha tthe land went out of cultivation. Over five thousand acres of formerly cultivated land under the Nira valley is now useless. But, in many cases, even where the amount of salt is not sufficient to cause crops to fail, it becomes more and more difficult to obtain a first-class crop, more and more manure is required for the purpose and, hence, the already very high cost of cultivation tends constantly to increase. Closely connected with this matter, too, is another factor which has had, I believe, a very economic effect. The rise in the subsoil water has made the canal area unhealthy, and what was formerly a district very free from malaria is now one of the most malarious in the Deccan.

We have, therefore, following on the great concentration of effort, capital, and water on one crop -sugarcane a large increase in credit, a large amount of money in circulation, a large return on capital if all went well, but a condition of things very risky for all but the most financially stable of the sugarcane growers. A year's lack of success places them in the hands of their financiers, from which they can only hope to escape by growing again the same crop. In the meantime, the expense required to get a first-class crop has been getting greater and greater, and hence the chance of a man who once made anything but a brilliant success of any particular crop getting over again into financial independence has been becoming less and less. The charges for interest and brokerage have, in fact, been so great, and the chance of the crop giving the highest yield has been getting less to such an extent, that it has been increasingly difficult for a man using other than his own capital to make his crop pay.

There has, in fact, been a tendency for the richer men in the valley who work on their own capital, still to make good profits though they acknowledge these to be much less than formerly. Many of the best of these, chiefly the Saswad *mális*, have departed to the more virgin land under the Godavari canal. Those who remain, however, still do well, tend to accumulate capital, and give an appearance of prosperity to the valley to an outsider. The much larger number, who are dependent on advances for growing their crop but who cannot cease growing it without definitely abandoning

their land to their financiers, are, I believe, not making money, bu becoming poorer and poorer, and tend to be financially more involved every year.

This may be a somewhat gloomy picture of a valley, where th canal has brought so much wealth, has changed a desert into garden, and has obtained so many advantages for the people. An I do not wish to exaggerate in the matter. Sugarcane cultivatio will still give good returns with skilful and careful managemen But the days when these returns could be got while paying fo financial aid at the rate which has been customary are, I believe, gon To make the industry pay in future will mean far more attention t drainage than in the past, far more care for levelling, far more troubl to get the best seed, far more skill in the selection and use of manure and attempts (as for instance, by the use of the Manjri metho of cultivation) to reduce largely the present cost of cultivation.

I expect the course of events will be more or less the same o nearly all canals, and especially on those which devote themselves t the cultivation of one particular highly profitable crop. Som men will succeed and become rich, others and the vast majorit may also do well for a time until the causes I have tried to descril become operative, and they find a declining crop, which they mu still cultivate, leading to hopeless financial bondage. To introduc at this stage improved credit facilities may help little, unless at th same time you bring in such agricultural improvements as will low the cost of production, or increase the yield, or improve the quality so that temporarily, at any rate, the return to the grower may b raised to the old rate. Then, and only then, will the improved cred facilities become really operative, and enable the cultivators wh have been almost swamped, to recover their economic independence

THE POSITION OF THE EUROPEAN SUGAR INDUSTRY AT THE END OF THE WAR.*

BY

H. C. PRINSEN GEERLIGS.

THE production of sugar in the European countries is again smaller this year than in the foregoing year, and still continues its downward course, as the table given underneath clearly shows:

Tons of 1,000 kilos.

Countries of production	1913-14	1914-15	1915-16
Germany	2,718,000	2,564,000	1,600,000
Austria-Hungary	1,688,300	1,619,000	938,900
France	781,000	295,000	150,700
Russia	1,688,000	1,939,000	1,667,100
Belgium	229,000	160,000	113,100
Netherlands	231,400	295,000	242,800
Sweden	137,200	154,000	127,300
Denmark	145,700	150,000	125,100
Other countries	542,800	500,000	300,000
TOTAL	8,161,400	7,676,000	5,265,200

Tons of 1,000 kilos.

Countries of production	1916-17	1917-18	1918-19
Germany	1,500,000	1,600,000	1,400,000
Austria-Hungary	935,000	700,000	900,000
France	207,000	200,000	100,000
Russia	1,325,000	1,000,000	700,000
Belgium	135,000	150,000	100,000
Netherlands	266,000	200,000	150,000
Sweden	118,000	120,000	100,000
Denmark	114,000	200,000	115,000
Other countries	250,000	200,000	240,000
TOTAL	4,850,000	4,290,000	3,805,000

* Reprinted from the *Louisiana Planter and Sugar Manufacturer*, vol. LXII, no. 9.

The causes of this decline are situated only for France in the direct consequences of the war, because in that country numerous sugar houses have been wrecked or damaged or dismantled to such an extent that out of the 206 factories existing before the war, only 61 have been able to do work in this year. It is quite certain that even after the conclusion of peace a large number of the idle ones will no more be rebuilt, which is to a great extent due to the fact that the constructing shops in France have also been deprived of their machinery by the invaders.

In all the other European sugar-producing countries the indirect consequences of the war have occasioned the sharp decline in the production. In the first place, the lack of supply of foodstuffs and fodder from overseas has stimulated the agriculture of potatoes, breadstuffs, oilplants and the like to the detriment of that of sugar beets, while also the area planted with swedes, turnips and similar hoe-crops has been greatly increased, bringing along a reduction in that devoted to sugar beets.

In many instances this decrease in the area planted with beet has been made voluntarily by the growers, but in many other cases they were compelled to do so by Government regulations. Except the necessity of cultivating direct food plants, which fetch a high price and for that reason present a certain attraction, other circumstances co-operated to decrease the beet sowings still more. The beetroot requires an intensive labouring and manuring of the land and much care and weeding, in order to produce a remunerative crop which requirements are difficult to satisfy in times of scarcity o people, horses, fertilizers and implements. Further, the beetroo is the latest crop in the year, being only ripe and saleable at a time when all other crops have already been disposed of. Finally, th beetroot wants to be pulled and hauled away within a very shor space of time. As soon as the beets are ripe, they have to be carte off before the frost will retard or even prevent pulling and trans portation, and if labour is short and means of transport not adequate the crop may lose in quantity and in quality. All these reason have induced many a farmer to restrict his beet sowings as fa

as is still in agreement with the need of pulp for his cattle or the requirements of his rotation of crops.

The planted area was, therefore, much smaller than in normal times; next, the output per acre of sugar on 100 parts of beets, too, is less, thereby decreasing the sugar crop for all these three reasons. The shortage of labour and of fertilizers caused the output per acre to be less than in other years, when every care had been bestowed to the growing crop. The lack of fodder for the cattle induced the farmers to cut off large pieces of root, when removing the heads and leaves, and to keep back small beets too for cattle food, thereby reducing still more the portion of their crop coming to the sugar house. Finally, many beets were used for the manufacture of coffee substitutes and for alcohol, which together resulted in a serious shortness of material for the sugar production.

The sugar-content of the beets in the field was not a high one, as a consequence of the small amount of tillage and weeding which had been done by the deficient labourers, and further the delayed pulling and transporting caused that small sugar-content to go down still more before the roots could be worked up. The lack of coal compelled the sugar houses to work slowly and with shorter or longer interruptions, all circumstances which decreased the rendiment of sugar from the beets. Finally, the shortage of fodder brought along the necessity of producing as large a molasses output as possible, and the price of sugar in molasses was so much higher than that in the ready article, that the manufacturers left as much sugar behind in the molasses as they possibly could and thereby decreased the output of sugar on 100 parts of beet. In countries where, before the war, sugar was extracted from molasses, this process was forbidden now, also in order to leave as much molasses available for cattle food as possibly could be obtained.

Besides all these reasons, there is still a very bad factor in Russia, where since the revolution the conditions for work are so bad and so disturbed that it is not clear how matters will come to their own again. In the part of the land still belonging to the old Russia, the production of sugar has come down from 300,000 tons to a mere 70,000, while in the other parts as Ukraine and Poland

the crop appears to be about one-half of the former figure, but no reliable data are to be had and the figure in the list is only an approximate one.

On the other hand, the consumption of sugar has been greatly increased, and had to be contingented if the nations did not want to be threatened by a complete absence of that article a long time before the advent of a new crop. The armies and navies consumed much more than their individual members would have done if they had been allowed to remain in their quiet civilian occupations, and further a not inconsiderable quantity of sugar was used as a raw material in the manufacture of explosives.

The civilian population, too, extended its sugar consumption, because of the lack of butter and fat to be smeared on bread and because of a great many other articles of diet having vanished from the bill of fare. The bad, grey and unpalatable bread had to be combined with honey, jams, marmalades and the like in order to be able to be eaten with the least possible amount of disgust, and all this demanded sugar and sugar again. It soon became evident that where the home production failed, the importation from abroad was rendered impossible either by the blockade or by the U-boat warfare or by both, and where the requirements for the armies and navies had to be satisfied above all, the consumption of the civilians at home had to be greatly rationed in every European country, while the amount of sugar put at the disposal of the industries using sugar as a raw material was cut down in most places to one-fourth of that in peace times.

At the end of the great war, at the moment of the signing of the armistice and of the beginning of peace negotiations, we see in Europe a bad sugar crop just ended, with very short stocks from the foregoing crop and very very little chance of importing sugar from overseas save for England, France and Italy. A severe scarcity of sugar is to be added to the already existing shortages of fat, bread, meat, coffee, tea, spices, fodder, milk, in short, of every article of food, and no visible way of escaping famine.

Moreover, in various countries voices are heard advocating the monopoly by Government of the sugar trade, thereby levying a

high duty on sugar as a means to pay off interest and amortization of the war loans, and where a monopoly is not yet planned, a great increase of the sugar duties is contemplated, also with a view to increase the revenue of the Exchequer. The consequence of both measures will certainly be a restriction of the sugar consumption in the countries concerned.

The prospects of the European sugar industry are anything but bright, and although the armistice is concluded and perhaps peace is at last in sight, the various reasons enumerated above, which have co-operated to decrease the production, will last still a very long time and will very probably keep the European sugar production at a much lower level than it used to occupy in the happier days before the dreadful war.

INCREASED YIELDS AS THE RESULT OF SWELLING SEEDS IN WATER.

THE following note communicated by Dr. Franklin Kidd and Dr. Cyril West, of the Imperial College of Science and Technology, is reproduced from the *Journal of the Board of Agriculture*, Vol. XXV, No. 11 :—

Much interest has been aroused recently amongst agriculturists as to the possibility of obtaining increased yields from seeds which have been submitted to treatments in which soaking in water or in salt solutions plays a part. It, therefore, seems appropriate to draw attention to this subject.

Some 40 years ago two German agriculturists of repute, namely, C. Kraus[1] and E. Wollny [2], [3] showed that increased yields could be obtained by swelling seeds in water.

Their main conclusions may be summarized as follows :—

(1) In order to obtain the best results the seeds must be swollen in the minimum amount of water necessary to saturate the seeds thoroughly. (If a large excess of water is used, the effect upon the subsequent growth and yield of the plants may be harmful.)

(2) The time of immersion should be sufficiently long for the seeds to become fully swollen.

(3) A subsequent redrying of the seed does not appreciably alter the beneficial effect of the treatment, but the redrying must not be carried out too rapidly.

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[1] Kraus, C. "Untersuchungen uber innere Wachstumsursachen und deren kunstliche Beeinflussung." Wollny's *Forschungen auf dem Gebiete der Agrikultur-physik*, I–IV, 1878-1881.

[2] Wollny, E. "Untersuchungen uber die kunstliche Beeinflussung der inneren Wachstumsursachen, VII, Der Einfluss des Vorquellens des Saatgutes auf die Entwickelung und die Ertrage der Kulturpflanzen." Wollny's *Forschungen auf dem Gebiete der Agrikultur-physik*, VIII, 1885, p. 380.

[3] Wollny, E. "Saat und Pflege der landwirtschaftlichen Kulturpflanzen." Berlin, 1885.

(4) The percentage of germination is liable to be slightly decreased by the treatment.

(5) Swelling seeds in solutions of nutrient salts has much the same effect upon yield as swelling the seeds in pure water.

(6) All the seeds tested (*i.e.*, the chief cereals and various other annuals of economic importance) gave the same result, with the exception of winter rye.

As the published results obtained by these agriculturists are accessible at only one or two libraries in this country, we may profitably record here a few of their figures.

TABLE 1.—(After Wollny).

Comparison of yields from (i) seeds swollen in water and sown in the moist condition, (ii) seeds swollen and redried before sowing, and (iii) untreated seeds.

The seeds were allowed to swell in the least possible amount of water necessary for complete saturation or 36 hours (the maize for 72 hours). The redrying process extended over 14 days, during which time the seeds were left exposed to the sun and air.

Kind of seed	Date of experiment	Treatment of seed	Number of plants: Original	Number of plants: At the harvest	Yield from 100 plants: Seeds	Yield from 100 plants: Straw	Average weight of 100 seeds	Percentage increase or decrease in yield of seeds from experimental plants as compared with that from the controls
					grm.	grm.	grm.	
Victoria peas ...	1877	Swollen, sown moist ...	64	58	532·9*	1324*	...	+ 29
		Untreated ...	64	59	413·3*	1443*	...	......
Beans ...	1877	Swollen, sown moist ...	64	57	920·5*	2436*	..	+ 27
		Untreated ...	64	60	727·6*	2215*	...	......
Victoria peas ...	1878	Swollen, sown moist ...	100	88	1188 6	1778	...	+ 23
		Untreated ...	100	94	967·0	1658	...	......
"	1882	Swollen, redried ...	92	74	548·6	1594	...	+ 9
		Untreated ...	97	76	502·6	1684	...	......
Vetch ...	1882	Swollen, redried ...	90	79	440·4	910	..	+
		Untreated ...	96	82	417 0	1074	...	......
Winter rye ...	1882	Swollen, sown moist ...	100	96	867·0	1510	..	− 6
		Untreated ...	100	100	925·0	1690	...	......

* Yield from 64 plants.

Table I.—(After Wollny).—*Continued.*

Kind of seed	Date of experiment	Treatment of seed	Number of plants: Original	Number of plants: At the harvest	Yield from 100 plants: Seeds	Yield from 100 plants: Straw	Average weight of 100 seeds	Percentage increase or decrease in yield of seeds from experimental plants as compared with that from the controls
					grm.	grm.	grm.	
Victoria peas ...	1882	Swollen, sown moist ...	95	84	602·0	2012	...	+ 10
		Untreated ...	97	90	548·0	1998	...	......
Vetch ...	1882	Swollen, sown moist ...	89	87	414·0	1138	...	+ 7
		Untreated ...	98	89	388·0	1146	...	......
Victoria peas ..	1883	Swollen, sown moist ...	69	62	445·0	1355	...	+ 16
		Swollen, redried ...	79	71	511·0	1408	...	+ 34
		Untreated ...	93	83	332·0	952	...	......
Beans ...	1883	Swollen, sown moist ..	99	99	869·0	1545	46·5	+ 9
		Swollen, redried ...	100	96	868·0	1459	45·6	+ 9
		Untreated ...	99	94	798·0	1468	38·8	......
Winter rye ...	1883-4	Swollen, sown moist ...	99	60	1160·0	1983	2·99	− 8
		Swollen, redried ...	95	83	1101·0	1831	3·17	13
		Untreated ...	93	70	1263·0	2314	3·14	......
Summer rye ...	1884	Swollen, sown moist ...	94	80	497·0	975	2·75	+ 5
		Swollen, redried ...	85	53	559·0	1302	2·38	+ 18
		Untreated ...	89	78	475·0	1051	2·57	......
Maize ...	1884	Swollen, sown moist ...	27	27	12515·0	46740	38·9	+ 11
		Swollen, redried ...	27	26	14792·0	47577	36·1	+ 31
		Untreated ...	27	27	11274·0	41630	36·4	......
Victoria peas ...	1884	Swollen, sown moist ...	96	92	730·0	1282	27·9	+ 9
		Swollen, redried ...	92	87	705·0	1310	29·4	+ 6
		Untreated ...	94	87	668·0	1184	28·7	......
Beans ...	1884	Swollen, sown moist ...	95	77	381·0	766	47·2	+ 3
		Swollen, redried ...	95	82	402·0	792	51·0	+ 9
		Untreated ...	94	80	369·0	725	47·7	......

Table II.—(After Wollny).

The harmful effect of soaking seeds in excess of water.

In these experiments the volume of water used was ten times that of the seed.

Kind of seed	Treatment of the seed	Number of plants at the harvest	Yield from 100 plants: Seeds	Yield from 100 plants: Straw	Average weight of 100 seeds
			grm.	grm.	grm.
Summer rye ...	Untreated	78	475	1051	25·7
	Soaked	65	359 (−24%)	877	22·7
Peas ...	Untreated	87	668	1184	28·7
	Soaked	84	546 (−18%)	1214	27·5
Beans ...	Untreated	80	369	725	47·7
	Soaked	77	264 (−28%)	766	54·4

From a careful analysis of the growth of the plants at various stages of development, conclusions were drawn as to the reason for the increased yields obtained. The plants from the treated seeds grew more quickly in the first few weeks, came into flower earlier, flowered for a longer period, and ripened off more slowly than the plants from the untreated seeds.

Schleh[1] and Eberhart[2] have later claimed to have demonstrated that the swelling of seeds before sowing will increase the crop yield. The following table gives one set of results obtained by Eberhart in a field experiment with beans.

TABLE III.—(After Eberhart).

Comparison of yield from (i) seeds swollen in water and sown in the moist condition, (ii) seeds swollen and afterwards redried, and (iii) untreated seeds.

Harvest results.

	Number of plants*	Weight of pods	Weight of straw	Average length of the stem	Average number of pods per plant	Weight of seeds
		grm.	grm.	cm.		grm.
Untreated seeds	96·0	609·0	776·0	97·75	4·19	474·3
Seeds swollen in water previous to sowing.	96·6	697·8	877·6	103·02	5·08	543·3 (+15 %)
Seeds swollen in water and re-dried before sowing.	95·3	677·1	875·6	101·71	5·6	526·3 (+11 %)

* Mean of three experiments.

The work referred to above indicates that a definite increase in yield may be obtained by swelling the seed in water. It is clear that the water factor must be taken into account in the consideration of any process for increasing crop production which involves soaking the seed.

[1] Schleh. "Steigerung der Ernteertrage durch Impragnation [illegible] mit konzentrierten Losungen von Nahrsaltzen." *Fühling's Landw. Ztg.*, LVI, 1905, p. 33.

[2] Eberhart, C. "Untersuchungen uber das Vorquellen der Samen." *Fühling's Landw. Zg.*, LVI, 1907, p. 159.

Elsewhere[1] the literature dealing with this water factor is critically reviewed, and also that dealing with the effect upon yield of the environmental conditions of the seed before harvesting, during storage, before sowing, and at the time of germination

[1] Kidd, F., and West, C. "Physiological Pre-Determination: The Influence of the Physiological Condition of the Seed upon the Course of Subsequent Growth and upon the Yield." *Review of Literature, Chapters I-IV, Annals of Applied Biology.*

THE ACTION OF MOULDS IN THE SOIL.[*]

The term "mould" is applied to various species of fungi isolated from the soil, which belong to widely scattered groups, and no sharp limitation is to be placed on the use of the term.

The importance of the action of moulds in the soil has been the subject of investigations by Selman A. Waksman, of the Department of Soil Bacteriology, New Jersey Agricultural Experiment Station, and he has recorded the results he obtained in a paper in *Soil Science*, August 1918. The question is of general interest to agriculturists in relation to soil fertility; a résumé of the paper is therefore given below.

When a group of micro-organisms is studied in relation to soil fertility, the question is—What part do they play in the nitrogen changes in the soil, produced as a result of their activity? From the early period of investigations on the microbial inhabitants of the soil, up to four or five years ago, the attention of soil bacteriologists was chiefly directed to the study of bacteria, neglecting other groups of micro-organisms to which the term moulds is applied. It has only been in very recent years that the great abundance of other micro-organisms, besides bacteria, in the soil has been demonstrated, and an attempt made to explain their part in soil fertility.

It has been definitely established that moulds, together with protozoa, algæ, etc., are common inhabitants of the soil, and form a large and important group of the soil flora. Hundreds of species of moulds have been isolated from the soil, and it has been found that many moulds occur in different soils under different topographic, climatic, and soil conditions. The same species has been isolated from soils in different European countries and from soils in various parts of America. New species, never met with before, have been

[*] Reproduced from *Agricultural News*, vol. XVIII, no. 438.

isolated from soil, serving as a proof that some of them at least are typical soil organisms.

It has also been found that moulds develop readily in acid soils, and are more active in forest and in compact poor soils, while bacteria predominate in loose soils rich in nutrient matter, cultivated and fertilized. In fact, in well cultivated lands containing relatively little humus, bacteria play a very important part, and occur in great numbers, and the moulds are of minor importance; while the upper layers of soil in forests, rich in humus as they are, contain a large number of moulds. In rainy seasons also the surface growth of moulds is greatly favoured; otherwise they live and produce spores below the surface among the vegetable residues and the living plant roots. It has been demonstrated that not only are moulds present in the soil, but that they actually live there, and produce mycelia, which necessitates their taking an active part in the different biological transformations of the soil.

Thus to be able to interpret the part played by these organisms in the soil, they must be studied as living organisms, which by their metabolic processes help in the various transformations of both organic and inorganic soil constituents, and in this way influence soil fertility.

The question of nitrogen fixation by moulds seems to be that, with the exception of some rather rare organisms, typical soil moulds do not play any direct part in the nitrogen enrichment of soils. Nor has the formation of nitrite or nitrate ever been demonstrated for any of the moulds, so that these important activities must be eliminated from the field of mould action.

On the other hand, the moulds are found to play a very important part in the disintegration of organic matter in the soil, particularly in the first stages of decay, which is termed ammonification. Whatever may be the process of formation of complex proteins by moulds, it is certain that ammonia is left in the medium as a waste product. If available carbohydrates are present, only small quantities of ammonia will be liberated by the action of bacteria and moulds; but in the absence of available carbohydrates there is a large amount of nitrogen left in the medium by their action. If the

ammonia is regarded as an indication of the amount of organic [illegible] decomposed by a living organism, some of the moulds commonly occurring in the soil are found to possess greater powers of decomposing organic matter than are possessed by bacteria. The action of the moulds on the nitrogenous organic matter in the soil may be said to consist in the mineralization of that material with the production of ammonia and the building up of fungus proteins. The ammonia is used by the higher plants as such, or is oxidized by nitrifying bacteria into nitrates, and so used by plants, or is absorbed again by the micro-organisms of the soils.

The moulds also play an active part in the decomposition of cellulose and other carbon compounds in the soils. This is of great importance, since both green and animal manures, and all vegetable residues, need to be decomposed before the minerals and nitrogen compounds can be brought to a condition in which they can either be taken up directly by the higher plants, or in which they can undergo other transformations due to the action of other groups of moulds or bacteria. It is stated that nearly all the simple and complex organic carbon compounds in the soil can be attacked by some group or other of moulds, which thus play an important part in soil fertility. The moulds attack the carbohydrates very readily, perhaps even more readily than the bacteria, and they cause rapid decomposition of these compounds. Although more information is necessary, it appears certain now that future theories of soil fertility will have to be constructed not only from the point of view of nitrogenous manures and fertilizers and nitrogen content of the soil, but also by taking into consideration the nature and amount of carbon compounds added to it.

It must be kept in mind, however, that lower plant organisms like moulds, when present in the soil, compete with the higher plants in utilizing nitrogenous compounds for their own growth. Thus the soil moulds may produce an unfavourable effect upon soil fertility. Although this cannot be denied, two factors may be mentioned as in some degree counterbalancing the possible injury to higher plants. First, an excess of ammonium salts or nitrates in the soil tends to large losses by leaching, especially under wet climatic

conditions, the utilization, therefore, of some of these salts by the soil moulds may serve usefully for the conservation of some of this nitrogen in the soil which would otherwise be lost. Secondly, the life processes of the moulds tend to the liberation of ammonia, and to the restoring again to the soil of the nitrogen assimilated by them in an available form. Thus moulds, from this point of view, may act in the soil as storing agents for soluble nitrogen compounds; and the possible injury caused by them in competing with the higher plants for the available nitrogen may be more than compensated for by their ability to store the nitrogen and make it afterwards slowly available for the plants.

Information up to the present leads to the belief that the mould flora is more active in acid than in neutral or alkaline soil, although it does not preclude the fact that moulds are developed also in the latter type of soil. It is possible that some of the soil moulds are active in the production of acids from available carbohydrates: thus soil acidity may be due in some part not only to the production of mineral acid owing to the oxidization of minerals or added fertilizers, but also to the production by soil moulds of organic acids, such as citric and oxalic. These acids may also act upon the insoluble phosphates and other minerals in the soil, and bring them into a soluble form available for the higher plants.

One other point with regard to moulds is worth noting. Plant pathologists know that a soil may become "sick" with respect to a particular crop, due to the fact that continuous cultivation of one crop on the same soil has caused that soil to become infested with large numbers of organisms pathogenic to that particular crop. Parasitic moulds of this type have, however, been isolated from virgin soils, or from soils on which the crop they parasitized has never been grown. Further investigations are needed as to how far the soil may be considered a possible medium for nourishing moulds likely to prove dangerously parasitic.

Notes

BOARD OF AGRICULTURE IN INDIA.

THE Eleventh Meeting of the Board will be held at Pusa from the 1st to the 6th December, 1919, when the following subjects will be discussed :—

I. Programmes of work of the Imperial Department of Agriculture and of the Director and First Bacteriologist, Muktesar.

II. Programmes of work of the Provincial Agricultural and Veterinary Departments and of Native States Departments of Agriculture.

III. The necessity for investigation into the conditions of nitrogen fixation in Indian soils.

IV. Whether there is any danger of reducing the level of fertility of Indian soils by the growing of high yielding varieties of crops and the adoption of intensive methods of cultivation, without, at the same time, providing an increased supply of manurial constituents. If so, how this danger can best be met.

V. The possibility of improving (*a*) forecasts, (*b*) final statistics of areas and yields of crops in India with special reference to the recommendations in Chapter XVII of the Cotton Committee's Report.

VI. Whether it would not be to the advantage of Indian agriculture that village *panchayats* should be incorporated, where this has not already been done, to raise local rates and to initiate land acquisition proceedings for the

purpose of constructing and maintaining agricultural roads, drainage and irrigation works, and the improvement of scattered holdings, and that the necessity of creating village *panchayats* for these purposes, where they do not already exist, should be impressed upon Local Governments.

VII. Whether the Agricultural Department should not undertake the writing of books of the following types :—

(a) Story books idealizing agriculture and rural life generally ;

(b) Popular bulletins describing improved methods of agriculture ; and

(c) School Readers containing lessons on subjects pertaining to agriculture, in order to interest literate Indian cultivators in their life's work and to assist in the improvement of rural education.

VIII. In view of the fact that the poor acreage outturns obtained in India are to a considerable extent due to the use of inferior tillage implements, what steps, if any, should be taken to encourage the manufacture of improved implements in this country on a large scale.

IX. The importance of conserving such natural sources of manure as oilcakes, bones and fish for use in the country. What practical measures can be adopted to attain to this end ?

X. The preparation for famine conditions so far as the Agricultural Department is concerned. Can any steps be taken in advance to meet famine conditions which may occur in the future ? Can any measures be adopted to prevent good strains of crops going out of existence in famine years ?

XI. Whether any special measures are necessary with regard to the initiation or control of extensive experiments with agricultural power machinery, with special reference to motor ploughs and tractors.

XII. A complete review and discussion of the permanent experimental plots at Pusa which were laid down by a Committee of the Board of Agriculture in 1908.

XIII. Whether it is necessary to reconsider the recommendations made by the Board of Agriculture of 1916 that Government should not restrict the export of cattle that are in demand abroad.

XIV. The improvement of cotton marketing in India, with special reference to the recommendations of the Indian Cotton Committee, paragraph 233.

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WHEAT YIELDS IN THE UNITED PROVINCES.

THE season which has just passed has not been a very good one for wheat. Some of it was sown late and much depended on the absence of hot west winds during the growing period. Unfortunately, there were a few days of hot wind at the beginning of March which damaged the backward crop and took several maunds off the yield. In consequence of this the outturns at the farms of the Agricultural Department have on the whole not been high and are lower than those of the past two seasons. But in some cases very high yields have been obtained even in this year, and I propose to describe the method of cultivation followed so that others who read this Journal may be induced to try it. If they do, perhaps they will themselves write and describe their experiences.

The department have been endeavouring to introduce the sowing of cane in shallow trenches, as promising the best and most certain results with improved varieties, both as regards germination and yield and sugar. Under this system, a trench two feet wide and six inches deep is dug: the earth in the trench so made is then dug with "kasis" to a further depth of nine inches and the available manure applied. Though somewhat more expensive than sowing on the flat, yet later on it saves much labour and trouble in earthing up the crop. It is essential for thick varieties which will otherwise fall down in the monsoon and the value of the cane greatly deteriorate.

It had been noted in previous years that this method of cultivating the land had a surprising effect on the succeeding wheat crop. It was more marked than usual on this year's crop. The land so cultivated had retained, except where the rains completely failed, sufficient moisture for sowing without irrigation, though in the neighbouring fields a "palewa" had often to be given before sowing. Good cultivators in these provinces are fully aware of the advantages of sowing on moisture, and make every effort to retain it even in canal-irrigated tracts.

At the Shahjahanpur farm the wheat on land which had been trenched the year before stood out above the crops of the neighbouring fields, though they too had been sown on natural moisture and on cane land which had received the same amount of manure but had not been trenched. The yields were excellent. At the Bijauria farm, Bareilly District, there was a block of wheat on six acres of such land. Up to March it was the finest wheat I had seen in India, and the Superintendent of the farm was confident that the yield would be well over 40 maunds per acre. Unfortunately part of it fell down with the heavy winds in March, and rats damaged the fallen ears. When threshed the average was just under 37 maunds. At the Shahjahanpur farm, the average yield of 3½ acres was much about the same, *viz.*, 36 maunds. This land had received no manure other than which had been applied to the previous cane crop, and was at the ordinary rate given to cane. The first of these crops was irrigated once only, that at Shahjahanpur twice. It would seem from this that quite apart from the advantages to the cane, this system of trenching will pay for itself in the next wheat crop. The cost of the operation is about Rs. 15 per acre, and considering that a good crop of improved cane will yield produce worth Rs. 350 to Rs. 450 per acre and that wheat is now selling somewhere about Rs. 5 per maund, the outlay is not excessive and the system should be worth trial in those districts where cane and wheat are commonly grown in rotation. But some strong-strawed wheat like Pusa 12 must be sown, or the heavy crop will fall with any wind or rain.—[The Hon'ble MR. H. R. C. HAILEY, in the *United Provinces War Journal*, dated 15th May, 1919.]

CERTAIN ASPECTS OF THE ORGANIZATION AND POLICY OF THE AGRICULTURAL DEPARTMENT IN BENGAL

A Resolution, dated 7th June, 1919, issued by the Government of Bengal, says:—

As it is desirable to place the public in possession of the intentions and policy of the Agricultural Department in the agricultural development of the Bengal Presidency, the Governor in Council deems it advisable to explain in some detail certain aspects of the organization of the department, together with some suggestions derived from the experience of other countries as to how the people can best benefit from its activities.

The necessity for private effort. The two main branches of the department are the research and demonstration branches. It is, however, clear that the activities of the department in respect of the demonstration of the results of the investigations of the research branch cannot be expected to reach more than a fringe of the agricultural population without the help of the public. On the one hand, the extent of such activities is conditioned by financial considerations; on the other hand, any development of the kind is of no avail if the people are not ready or cannot arrange to take advantage of it. Individually the agriculturist is ready; experience in this country has shown that if he can see with his own eyes the value of an improvement he will adopt it. But if all are to benefit, experience in other countries shows that the agriculturists must meet Government half-way in the matter. It has been found in those countries that, if small associations of agriculturists are formed to test and adjudicate on suggested improvements, to discuss their successes and failures with each other, and to bring their needs to the notice of the Agricultural Department, then not only is the practical problem of how to reach the whole agricultural population solved, but there is hardly any limit to advancement in the direction of improved production, economic distribution, improvements of breed and indeed in all mental and moral development. In the words of an American Professor of Political Economy, Dr. J. A. Ryan, "The transformation in the rural life of more than one European

community through co-operation has amounted to little less than a revolution. Higher standards of agricultural products and production have been set up and maintained, better methods of farming have been inculcated and enforced, and the whole social, moral and civil life of the people has been raised to a higher level. From the view-point of material gain, the chief benefits of agricultural co-operation have been the elimination of unnecessary middlemen, and the economies of buying in large quantities, and selling in the best markets, and employing the most efficient implements."

An essential condition, however, for the success of such associations is that they should be conducted on the basis of self-help. It is desirable for Government to assist such associations by teaching and exercising close control; but interference with their management or the grant of pecuniary aid by Government impairs the fundamental principle of self-reliance.

Formation of small agricultural associations in Bengal. What precise form private effort should take in Bengal, it is perhaps too early to prophesy. But undoubtedly there is every reason to believe, from the experience gained in other countries, that the formation of small agricultural associations should prove successful, whether as simple associations formed for the purpose mentioned in the preceding paragraph, or as co-operative societies dealing with the purchase of seeds and implements or with the distribution of agricultural produce. There is probably room for associations combining one or more of these functions. Apart from foreign experience and experience in other provinces in India, there is also the definite fact that such simple associations, serving thanas or even smaller areas, have met with marked success in the district of Birbhum in the Bengal Presidency. By the co-operation of official organization and private effort of this nature not only will the successes obtained by experiment be brought to fruition in the interior, but Government will be furnished with a first-hand agency for ascertaining the real needs and the wishes of the agricultural population.

His Excellency in Council hopes, therefore, to see a further extension of this experiment throughout the province, particularly

in those districts in which demonstration farms already exist or are about to be established, as it is in those districts that the Agricultural Department can give the most help. The formation of such associations rests, however, with the public; and they will only be successful if they are financed and managed by the people. The principle accepted as essential by the Board of Agriculture in India, at their seventh meeting in 1911, was that those who are associated should all be agriculturists, really interested in local agricultural improvement.

The officers of the Departments of Agriculture and Co-operative Societies will be ready at all times with their advice and counsel.

Functions of existing associations. The extension of such small associations, if carried into effect, will inevitably involve some alteration in the functions of the existing provincial, district and divisional agricultural associations. The district associations may, for example, find, as time goes on, that their executive functions are being gradually absorbed by the working village societies. For the present, they may find that their duties are devoted to the organization of such societies. The development will of necessity be a gradual process, and the present associations will doubtless adapt themselves to changing circumstances or give way to a different organization if they cease to satisfy a real need.

The divisional associations, in particular, may not be required, while experience may show that the functions at present discharged by the provincial association can be more effectively performed by the new Board of the Agricultural Department which has been created.

Establishment of demonstration and seed farms. The research work of the department, or, more properly speaking, the investigation work, is mainly conducted at the Dacca Agricultural Station, which is the headquarters of the chemical, botanical and fibre sections, while there is a smaller investigating centre in West Bengal at Chinsura. At these centres problems of practical utility to Bengal agriculturists are investigated, such as the production of improved rice, jute and sugarcane, the suitability of various fertilizers, the

prevention of insect pests and so on ; and not, as there is a tendency in some quarters to believe, research work of a purely academic interest. For the purpose of testing the results obtained at these research stations and demonstrating their value, smaller stations or farms have been established at Rajshahi and Rangpur. Private farms at Burdwan and Kalimpong are also managed by the department. The utility of these stations has been fully proved and the necessity for small farms in every district accentuated, owing to the success attained in the plant-breeding sections of the department. It has thus become necessary to arrange for the establishment of a demonstration and seed farm in each district, for the dual purpose of adjusting the results of scientific investigations at the central research stations to local conditions and of taking up the study of purely local problems. Each farm will form a centre for the demonstration of such items as have been found by actual tests to be suited to local conditions. A programme is, therefore, under contemplation for gradually providing every district in Bengal with a demonstration and seed farm as soon as practicable, whilst official sanction has already been accorded to the establishment of such farms at Mymensingh, Bogra and Comilla.

Co-operation of District Boards in establishment of farms. In view of the popular interest in agriculture, it has also been considered desirable to enlist the interest of the District Boards by requesting them to co-operate in the establishment, maintenance and management of the farms, subject to the professional control of the Agricultural Department.

In the view of His Excellency in Council the forms which the assistance from District Boards may legitimately take are as follows :—

(1) Provision of land or of money towards the acquisition of the land or towards the necessary buildings.

(2) Provision for the whole or a portion of the recurring expenditure on a farm.

The Governor in Council holds that District Boards should possess a voice in the management of the farms to the extent to which they contribute, subject to the professional control of the

department. Certain District Boards have already agreed to co-operate on these lines.

Demonstrators. For the purpose of advertising the results obtained at the central research stations and on these farms and of advising the small agricultural associations which are expected to come into being, definite circles, such as the area of a police station, are necessary for demonstration work in charge of demonstrators working under the supervision of agricultural officers. Twenty six district agricultural officers, *i.e.*, one for each district in the presidency, have now been sanctioned; five additional agricultural officers have also been appointed for special work: and there are at present altogether 79 demonstrators. It is contemplated that, with the completion of the programme for the construction of farms and the multiplication of small agricultural associations, the number of these demonstrators will be gradually but largely increased, until there is one for each police station in Bengal.

Seed-stores. Experience in Bengal has shown that the immediate result of successful demonstration at any of the farms already in existence is a demand for improved agricultural appliances, and for seed of a new crop or of a new variety of crop. In fact, agricultural improvement in India necessitates in nearly every case the use of some new thing, whether it be seeds, fertilizers, implements or insecticides. This is exemplified by the insistent and growing demand for seed-stores in those districts where seed of a new crop variety has been issued. One seed-store will not be sufficient in a district; but seed-stores should be established also at every subdivisional headquarters and at all demonstration centres. To produce the best results such seed-stores should, however, be established and maintained by such bodies as agricultural associations or co-operative societies or local authorities. It is not, therefore, the policy of Government to establish and maintain such seed-stores themselves for areas smaller than a subdivision. Not only would this involve too large a commercial undertaking for a Government—where attempted in other countries, it has ultimately been abandoned for this reason—but it would involve too great an encroachment on the sphere of private effort. There are already

30 stores in existence under the auspices of Government, and . are being created under local organizations.

General policy. By the continuance of investigation for practical ends at the central farms, by the creation of demonstration farms in every district and seed-stores in every subdivision, by the appointment of a staff of agricultural officers and demonstrators in sufficient numbers to aid district officers and the department on the one hand, and the agriculturists, either individually or in association, on the other, the Bengal Government are aiming at the solution of the two problems which the Agricultural Adviser to the Government of India has declared to dominate the whole situation : the first is the provision of the best obtainable seed for any type of agricultural produce, and the second the creation of an agency for its distribution.

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THE following further extracts from official reports dealing with the use of **cactus** in the Ahmednagar District **as a fodder substitute** have been published by the Bombay Government : —

Extract from a Report No. B.—854—1918, dated 29th May, 1919. *from the Honourable Mr. L. J. Mountford, C.B.E., I.C.S., Commissioner, Central Division.*

After touring through parts of four tálukas of the Ahmednagar District and inspecting cattle camps and villages where cattle are fed on cactus, I am of opinion that the villagers have a very valuable fodder adjunct for their *kadbi* (*Sorghum* stalks) in cactus properly prepared, and consider it would be well if our expert veterinary officers could give a definite opinion on this point.

The preparation is simple. It consists in roasting the cactus over a village forge and chopping it up fine. The thorns catch fire readily, and with very little care all thorns can be destroyed. In some places women also extracted the charred tufts. This is not considered necessary, but it probably assists digestion. An admixture of strengthening food is advisable where *kadbi* is not available. In Ahmednagar, they add two pounds of cotton seed and occasionally one pound *chuni* (gram and lentil husks) to the 24 pounds full feed.

In the camps and kitchens I visited, I found cattle eating the stuff greedily. Some cattle and buffaloes will eat the pear leaves whole, but chopped fodder is best. The people are quite enthusiastic, and, from reports received, some villages have taken to this fodder almost in a body, such as Brahmanwada (Akola) and Pedgaon (Shrigonda) and many others.

Cactus operations are not new to Ahmednagar, as they were carried out in 1912; but the village busy-body was not absent. Various rumours were started which at first somewhat impeded the campaign, such as that compulsory payment would be insisted on when the cactus campaign was closed; that the animals would die, and, when it was found that animals did not die, that they would die off in the rains. This prophecy still obtains among cactus opponents.

Villagers visit the camps and kitchens with their cattle, or ask to be allowed to take some rations away to their villages; where possible, choppers, bellows and prongs are given them. Many come to Mr. Beyts's bungalow for instruction, and while I was there, two very fine cattle in splendid condition were brought by their owner to be taught to eat cactus. I have seen cattle brought in by their owners eat their ration for the first time straightaway.

Cattle which had not the strength to raise themselves from the ground two months ago in some of the camps, are now able to do light work at the *mhote*, and to pull the cactus carts. Mr. Beyts purchased many miserable animals in the last stage of exhaustion from the butchers for a few rupees, and, after feeding them on cactus preparation, has sold them to the ryots for three times the purchase money. Mortality was very heavy before the cactus campaign started. One owner told me he lost seven of his cattle that he had fed on grass purchased for Rs. 2,000; and that he had lost none since he took to cactus. The mortality in the cactus camps has been slight.

At present there are over 34,000 cattle feeding on cactus, and it would have been utterly impossible to find grass or *kadbi* to feed these cattle. They would require at eight pounds of grass or *kadbi* a day (a low all-over daily average for cattle and young stock) some

272,000 pounds or over 80 lakhs per month. This amount of grass could not be obtained.

The present price of *kadbi* in the market varies from Rs. 40 to Rs. 60 per 1,000 pounds, while the cost of 1,000 pounds of cactus, cleaned, chopped and prepared for food is Rs. 2, to which is added Rs. 5 worth of cotton seed which is very expensive at present. *Chuni* is often added where procurable, but is not essential.

Cactus no doubt possesses a certain feeding value, but is most useful when used with cotton seed. It can also be mixed with chopped *kadbi* in the proportion of 2 to 1, and if, as is hoped, the ryots will recognize what a valuable green fodder they have all around them, the fodder resources of the country will be vastly increased, and future famines will be robbed of much of their terrors. In 1912 cattle preferred prepared cactus to the famine grass that was available that year.

I visited a charitable grass camp at Ahmednagar and elsewhere, and found the animals in no better condition than in the cactus camps. Where, as happened in both classes of camps, animals came in a very poor condition, mortality was to be expected. In one grass camp the mortality was 20 per cent. and there were many animals on the sick list, and I understand the mortality in the cactus camps did not approach this figure. I came to the conclusion that dry grass alone is not sufficient for famine cattle. In the first place, really good grass of sufficient nutriment is difficult to procure; and, secondly, some green stuff is necessary. Cattle appear to thrive better on cactus with the adjuncts employed in Ahmednagar. Again, foreign grass often disagrees with cattle. Although the local cattle in the Dángs thrive on grass, there were very heavy losses among the Ahmednagar cattle sent there, and those that returned came back in a miserable condition.

Extract from a Report No. 1996, dated 11th June, 1919, from Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., F.R.C.V.S., Superintendent, Civil Veterinary Department, Bombay Presidency.

I have visited cattle camps in the Ahmednagar and Poona Districts where cattle are being fed on prickly pear, and recently

(May 11th to 15th) I made a detailed inspection in the Ahmednagar District in this connection. I paid surprise visits to a number of villages in various directions where the fodder was being used, and visited the camps at Ráhuri, Shrigonda and Wakodi. I also visited the charitable camp at Ahmednagar where the cattle were being fed on dried grass and *kadbi*, no prickly pear being used.

I can bear out the Hon. Mr. Mountford's statements in every particular. There can be no doubt that cattle can be maintained on prickly pear when necessary without harm. It is not claimed that it ranks as a good fodder, and it should be supplemented with a certain amount of dried grass if possible in addition to some proportion of concentrate. Cattle require a proportion of green fodder to keep in good health, and the dried grass that passes as hay in this country is frequently so inferior and innutritious that it causes internal disorders, especially in debilitated cattle. Animals have their idiosyncrasies, and there may be cases where prickly pear causes indigestion, especially if it is improperly prepared. It is essential that all the prickles should be removed. Like all green fodders it produces some looseness of the bowels, which is considered normal to cattle in countries where green fodder is common. Any excessive looseness can be remedied usually by supplying fodder in intelligent proportions. Diarrhœa in cattle in the rains is common from various causes. I have written a leaflet on the subject, which is being published by the Agricultural Department in English and three vernaculars.

I beg to say that in my opinion the cactus fodder campaign, particularly in the Ahmednagar District, has been a great success, and that by the aid of this fodder a very large number of cattle that would otherwise have died have been saved. The work in the Poona District has also been effectual. A very pleasing feature in the Ahmednagar District is the obvious satisfaction of the cattle-owners when once they have been persuaded to take up the method. They have learned to appreciate its advantages, and in many places their own arrangements are well devised and working well.

In the *Rhodesia Agricultural Journal*, December 1918, there is some advice as to plants suitable for forming cattle-proof hedges on Rhodesia. Among these is Bougainvillæa, especially the species *glabra* and *spectabilis*. This is used as an ornamental hedge in some of the West Indian islands, and is certainly of a strong enough growth to form a close hedge of any height or width which may be desired. The blaze of colour in the flowering season, which is almost the whole year, makes it a most showy object. The two species of Bougainvillæa mentioned above grow easily from cuttings inserted in the ground. Until growth starts, they should be kept well supplied with water. The plants are extremely hardy, and when established, will stand long periods of drought.

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The Rothamsted Experimental Station has been engaged for some time in field trials and other investigations to discover what value ammonium nitrate possessed as a fertilizer. Dr. E. J. Russell thus summarizes the general results of the experiments in the *Journal of the Board of Agriculture*, Vol. XXV, No. 11 :—

(1) Ammonium nitrate is an excellent fertilizer, the nitrogen of which is worth as much as that in nitrate of soda and sulphate of ammonia. At present prices of these two fertilizers, ammonium nitrate would, on the same basis, be worth £37 5*s.* per ton.

(2) It contains more than twice as much nitrogen as nitrate of soda, and one and three-quarters times as much as sulphate of ammonia : it is thus the most concentrated nitrogen fertilizer obtainable on the large scale. Where 1 cwt. of nitrate of soda or ¾ cwt. of sulphate of ammonia is ordinarily used, less than ½ cwt. of nitrate of ammonia would be required.

(3) It can be applied to any crop for which nitrate of soda is suitable, but it is not superior to sulphate of ammonia for potatoes, and may be inferior. Its proper use is as a top-dressing, and not as a constituent in mixed manures.

(4) Farmers must insist on having the "non-deliquescent" variety, otherwise they will certainly be inviting trouble.

(5) While the material itself is not inflammable, it yet helps a fire considerably. Great care is, therefore, necessary not to store under conditions where a fire might be started.

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THE COCOA PRODUCTION OF THE EMPIRE.

Among the products of the Empire which before the war were not utilized in the United Kingdom to the extent they might have been, cocoa takes a prominent place. The quantity of cocoa produced in British countries in 1913 was more than three times the amount consumed in the United Kingdom, yet that country only obtained about one-half its supplies from those sources, the remainder consisting largely of South American cocoa and foreign cocoa shipped *viâ* continental countries. Not only was this the case, but the British Isles were importing large quantities of prepared cocoa and chocolate from foreign countries which had been manufactured there from British grown cocoa. During the war the position improved and a much larger proportion of the raw cocoa came from the Empire, no less than 86 per cent. of the total imports coming from British possessions in 1917, and it is to be hoped that this state of affairs will continue. The importance of the matter will be realized when it is stated that in 1916 the total imports were valued at no less than six and three quarter million pounds sterling. The question of the production of cocoa in the different countries of the Empire, the world's consumption, and the cocoa trade of the United Kingdom is fully discussed in an article in the January–March (1919) Number of the "Bulletin of the Imperial Institute." Of the many interesting points brought out, two call for special mention. The first is the unprecedented growth of the cocoa industry in the Gold Coast, where the product is grown and prepared for the market entirely by the natives. The colony commenced to export cocoa in 1891 and it now produces more than one-quarter of the world's output. The other equally remarkable fact is the enormous increase in the consumption of cocoa in the United States in recent years. The consumption has trebled since 1913 and about one-half the total quantity produced in the world now goes to the States.

The cocoa industry of the Gold Coast is also dealt with at length in a message addressed to the Legislative Council of the Colony by Sir Hugh Clifford, the Governor, which appears in the same Number of the Bulletin.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

WOODHOUSE-SOUTHERN MEMORIAL FUND.

DONATIONS received up to the 31st May, 1919, and acknowledged in the *Agricultural Journal of India*, Vol. XIV, Pt. IV, July 1919	1,930
Donations received during the period from 1st June to 31st August, 1919:—	
V. G. Gokhale, Esq.	10
S. K. Basn, Esq.	10
TOTAL ..	Rs. 1,950

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THE names of the undermentioned have been brought to the notice of the Government of India for valuable services rendered in India in connection with the war up to 31st December, 1918 :—

The Hon'ble Mr. H. R. C. Hailey, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.

Mr. B. C. Burt, M.B.E., B.Sc., Deputy Director of Agriculture, Cawnpore.

Colonel J. Farmer, C.I.E., F.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Punjab.

Colonel H. T. Pease, C.I.E., M.R.C.V.S., Principal, Veterinary College, Punjab.

Mr. J. G. Cattell, M.R.C.V.S., Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana.

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LIEUT. (TEMP. COL.) GEOFFERY EVANS has been appointed an additional Companion of the Most Eminent Order of the Indian Empire in connection with the military operations in Mesopotamia.

MR. P. P. M. C. PLOWDEN, I.C.S., Joint Magistrate, Agra, has been appointed Under Secretary to the Government of India, Revenue and Agriculture Department.

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MR. W. A. DAVIS, B.Sc., A.C.G.I., has been granted special privilege leave for five months with effect from the 11th October, 1919.

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MR. G. S. HENDERSON, N.D.A., N.D.D., Imperial Agriculturist, has, on the termination of his deputation under the Munitions Board, been granted with effect from 23rd June, 1919, combined leave for six months, *viz.*, privilege leave for 3 months and 10 days and study leave for the remaining period.

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MR. J. H. WALTON, B.A., B.Sc., Supernumerary Agricultural Bacteriologist, Pusa, has been granted combined leave for six months.

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THE services of Mr. M. Afzal Husain, B.A., Supernumerary Entomologist, Pusa, have been placed at the disposal of the Government of the Punjab.

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MR. J. F. DASTUR, M.Sc., who has been appointed to the Indian Agricultural Service, is appointed Supernumerary Mycologist at Pusa, with effect from the 30th June, 1919, and deputed to England for fifteen months for training.

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MR. W. A. POOL, M.R.C.V.S., on reversion from military service, has been appointed Second Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, with effect from the 30th July, 1919.

MR. G. A. D. STUART, I.C.S., is granted combined leave for one year with effect from the date of relief of his officiating appointment as Agricultural Adviser to the Government of India.

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MR. R. H. ELLIS, I.C.S., has been appointed to act as Director of Agriculture, Madras, in relief of Mr. R. Cecil Wood, M.A., and until further orders.

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MR. R. C. BROADFOOT, Probationary Deputy Director of Agriculture, Madras, has been appointed to act as Superintendent, Central Farm, Coimbatore.

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MR. P. H. RAMA REDDI, Probationary Deputy Director of Agriculture, Madras, has been appointed on completion of his training to act as Deputy Director, II & III Circles, *vice* Mr. G. R. Hilson granted leave or until further orders.

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MR. P. C. PATIL, L.AG., who has been appointed to the Indian Agricultural Service, has been confirmed in the appointment of Deputy Director of Agriculture, Northern Division, Bombay, from the 1st March, 1919.

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MR. BHIMBHAI M. DESAI has been appointed Deputy Director of Agriculture, Gujarat, with effect from the 1st April, 1919.

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MR. D. L. SAHASRABUDHE, B.SC., L.AG., Assistant Professor of Chemistry at the Agricultural College, Poona, has been appointed to act as Agricultural Chemist to Government, Bombay, with effect from the 1st June, 1919, pending further orders.

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MR. G. TAYLOR, M.R.C.V.S., Superintendent, Civil Veterinary Department, South Punjab, has been appointed to officiate as

Superintendent, Civil Veterinary Department, Bombay, with effect from the 12th July, 1919, *vice* Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., F.R.C.V.S., appointed to officiate as Principal, Veterinary College, Lahore.

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MR. A. D. MCGREGOR has been appointed to act as Superintendent, Civil Veterinary Department, Bengal.

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MR. RAJESWAR DAS GUPTA, who has been appointed to the Indian Agricultural Service, has been confirmed as Deputy Director of Agriculture, Bengal, from the 1st April, 1919. He has been placed in charge of the Northern Circle, but will continue to act as Deputy Director of Agriculture, Western Circle, in addition to his own duties, during the absence of Mr. F. Smith on leave.

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MR. N. S. MCGOWAN, B.A., Professor of Agriculture, Agricultural College, Sabour, has been granted combined leave for one year from the 1st April, 1919. Mr. Surendranath Sil, B.A., M.Sc. A., officiates as Professor of Agriculture during Mr. McGowan's absence.

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MR. T. F. QUIRKE, M.R.C.V.S., Superintendent, Civil Veterinary Department, North Punjab and North-West Frontier Province, has been granted combined leave for six months with effect from 26th May, 1919. Mr. J. S. Garewal, M.R.C.V.S., officiates in Mr. Quirke's place.

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RAI SAHIB LALA KOTU RAM, Deputy Superintendent, Civil Veterinary Department, has been appointed to act as Superintendent, Civil Veterinary Department, South Punjab, *vice* Mr. G. Taylor transferred to Bombay.

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MR. H. E. CROSS, M.R.C.V.S., Civil Veterinary Department, Punjab, has been granted an extension of furlough for eight months.

Mr. F. J. Plymen, A.C.G.I., Deputy Director of Agriculture, has resigned his seat on the Legislative Council of the Chief Commissioner of the Central Provinces.

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Mr. G. Evans, C.I.E., M.A., on the completion of his special duty in Burma, has returned to the Central Provinces.

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Mr. A. G. Birt, B.Sc., Deputy Director of Agriculture, Assam, is allowed combined leave for one year and four months with effect from the 24th June, 1919. Srijut Lakheswar Barthakur, Superintendent of Agriculture, Assam Valley, is appointed to officiate.

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Mr. E. S. Farbrother, M.R.C.V.S., is confirmed in the Civil Veterinary Department and appointed to officiate as Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana, with effect from the 1st July, 1919.

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The seventh annual meeting of the Indian Science Congress will be held at Nagpur from the 12th to the 17th January, 1920.

Sir Benjamin Robertson, K.C.S.I., K.C.M.G., C.I.E., Chief Commissioner of the Central Provinces, has consented to be Patron of the meeting, whilst Sir P. C. Ray, C.I.E., D.Sc., Ph.D., Palit Professor of Chemistry, Calcutta University, will be its President.

The Sectional Presidents will be :—

Applied Botany and Agriculture. Mr. D. Clouston, C.I.E., M.A., B.Sc., Offg. Director of Agriculture, Central Provinces.

Physics and Mathematics. Dr. N. A. F. Moos, F.R.S.E., formerly Director, Bombay and Alibag Observatories.

Chemistry. Mr. B. K. Singh, M.A., F.C.S., Offg. Professor of Chemistry, Government College, Lahore.

Systematic Botany. Mr. P. F. Fyson, B.A., F.L.S., Professor of Botany, Presidency College, Madras.

Zoology. Mr. E. Vredenburg, B.L., B.Sc., A.R.S.M., A.R.C.S., F.G.S., Superintendent, Geological Survey of India.

Geology. Mr. P. Sampatiengar, M.A., F.G.S., Offg. Geologist, Department of Geology and Mines, Mysore.

Medical Research. Lieut.-Col. J. W. Cornwall, M.A., M.D., D.P.H., I.M.S., Director, Southern India Pasteur Institute, Coonoor.

Further particulars of the meeting may be obtained from the Honorary Secretary, Dr. J. L. Simonsen, Forest Research Institute, Dehra Dun.

Reviews

Forecasting the Yield and the Price of Cotton. By H. L. Moore. (Macmillan & Co.)

The United States produces more than one-half of the total world's output of cotton of 30 million bales, but, owing to the organization of the American trade, the price of cotton in every market in the world depends more on the American price than the relative American production alone would indicate. The prediction of the yield and price of American cotton is, therefore, a matter which concerns the whole cotton-buying world. In applying the method of correlation to the problem of the yield of American cotton Professor Moore has been anticipated by Kincer. But Kincer, though he obtained a high value for the correlation, did so by multiplying his rain and temperature variables by more or less arbitrary coefficients, which themselves depend on the antecedent climatic conditions. By choosing a sufficient number of such coefficients any correlation however high can be obtained, and there is no assurance that the formula of prediction is anything more than an empiricism, summing up past events, but of no use in predicting future ones. To this criticism the whole theory of correlation, except where it is used to measure quantitatively the association between known 'veræ causæ,' and their effect is, to some extent, exposed. In using the method of multiple correlation, in particular, long series are necessary if the number of variables used is at all large. Thus Professor Moore uses the rainfall in May, and the mean temperatures of June and August to predict the yield of cotton in Georgia, and obtains a multiple correlation coefficient of 0·732, which suffices to cut down the error of prediction to about 70 per cent. of the error of a pure guess based on the mean outturn. But the series, from which the 3 total correlations are obtained is only one of 20 years,

and this somewhat modifies, though it does not entirely vitiate, the value of the formula of prediction. The results obtained for Georgia suggest that high rainfall in May and high temperature in August are harmful to the cotton crop, while in June high temperatures are beneficial. To what extent these are true effects of rainfall and temperature, or merely the result of some allied condition, such as plant disease, which in its turn is dependent on climate, cannot of course be stated off-hand, nor indeed, for a first approximation forecast, does it matter. For the prediction of the price of Upland cotton from the total American output in bales, even higher correlations are obtained. For example, the correlation between the percentage change in price and the percentage in production is found to be $-0{\cdot}819$ and the multiple correlation co-efficient between the price of Upland cotton and the combined factors of total production of cotton and index prices of all commodities is $0{\cdot}859$, from which the error of prediction can be reduced to one-half of the standard deviation of the price of cotton from year to year. It appears, however, to be nowhere stated on what date the price is taken.

Though Professor Moore has obtained some useful results, and has shown conclusively that from climatic conditions the American cotton crop can be forecasted in nearly every case more accurately than the official forecast succeeds in doing, and that often a month earlier, it is impossible to admit that he has obtained a complete solution of the problem of cotton prices, or indeed that such a solution can be found from the mere application of the method of multiple correlation, as Professor Moore appears to imagine (p. 151). That an immense improvement in official crop forecasts can be effected by the method of correlation has been known in India for many years, and it has been shown that some sugarcane forecasts are, like the May American cotton forecasts, worse than useless; but to suppose that a final physical, chemical, physiological and economic phenomenon solution is to be obtained by pure statistics is a misconception, which nevertheless should not blind us to the merits of the methods evolved by Francis Galton and Karl Pearson.

In another respect Professor Moore seems to go above his last in attempting to better the official forecast of cotton based on the

condition-ratio figures issued on the 1st of May, June, July and August. These figures Professor Moore correlates with the corresponding yield-ratios, and finds as was to be expected that the correlation is less than unity. He then constructs the regression equation of yield-ratio on condition-ratio, and offers this as a better prediction formula than the official prediction itself. This is an astonishing perversion of the method of statistics. Fortunately the author only seems to treat this prediction formula as a side issue, but as it has no meaning whatever it should not have been introduced.

To sum up, the book is a definite step on the lines of attack of the problem of forecasts adopted by Hooker, Warren Smith and others. [S. M. J.]

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Farmers' Clean Milk Book—By CHARLES EDWARD NORTH, M.D. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall.) Price 5*s*. net.

THIS book is got up on the popular style. The matter is expressed in non-technical language and will appeal to a very wide circle of readers. Although the advice is useful, nothing fresh is given to dairymen who carry on their work in an up-to-date manner. It may naturally be inferred from the publication of a work of this kind that the health authorities think that there is still much headway to make in producing safe milk in America.

While some information regarding the entry of the disease-producing bacteria into milk is given, and while pasteurization is described in a general way, an important point, namely, the thermal death-point of disease-producing germs and the exposure required at a given temperature to kill them, is omitted. In other words, the temperature of pasteurization and the time for which milk should be kept at that given temperature under different conditions have been passed over. Since the ordinary conditions of practical dairying differ considerably from those in the laboratory, Dr. North might have instructed his readers on points regarding temperature and exposure required to kill the more important pathogenic bacteria.

The importance of the personal element, namely, persons working with milk being cleanly as regards themselves, and also as regards cows and dairy utensils, is a point with which all will agree. Dr. North has demonstrated this by arranging for good dairymen to take over temporarily inefficient dairies and manage such in an up-to-date manner. The results obtained are very striking indeed, and one is surprised that there should be still in America such backward methods in practice.

Apparently in America most milk producers object to the frequent visits of the dairy inspectors, as they add to the cost of producing milk. Such things as up-to-date management of cattle, buildings, pasteurizing, etc., etc., all cost money, and add very considerably to the cost of production. It is here that the health authorities, the producers and the consumers appear to come into conflict. The consumer wants cheap milk, the health authorities demand that milk should be produced on up-to-date lines, thereby adding to the cost of production; while the milk producers insist that the increased rates paid for an up-to-date milk supply are not commensurate with the increased expenditure.

While the book aims at educating the milk producers and dairymen, little has been demonstrated on the lines of educating public opinion on the value of a satisfactory milk supply. Some hints to milk consumers generally would also have proved useful and added to the value of the work.

In the closing chapter, dairy arithmetic is dealt with, and it is there shown that, taking the food item alone, good milking cows produce milk at a lower cost than bad milking cows. The statement, while correct, is very incomplete, as at least 13 other items add their quota to the cost of milk production. Such statements are liable to create in the mind of consumers some suspicions as regards farmers' profits. In cases of this kind, one should like to see the subject of costs either fully dealt with or entirely omitted.

On the whole, the book contains useful information and may be read with advantage. [A. C.]

Correspondence

INTERMITTENT BEARING OF FRUIT TREES.

To The Editor,

The Agricultural Journal of India.

Sir,

In a note published on page 673, Vol. XIV, Part IV, of your journal, and entitled "How to avoid intermittent bearing of fruit trees," there appears a review of an article from "Country Life." The author of the article attributes the non-bearing of certain fruit trees in alternate years to the exhaustion of all reserve material during the years of abundant bearing. He considers that this may be rectified by a liberal supply of easily assimilable manure at the time of the formation of fruit buds for the coming year. In support of this suggestion he cites the regular bearing of espalier trees and trees under glass.

Readers of your valuable journal may be interested to know that the same question with reference to apple trees, is discussed in an illustrated article in the "Journal of Heredity," Vol. IX, No. 7, November 1918. The author, Mr. B. S. Brown, considers this biennial bearing condition to be a "habit" forced on the tree by conditions of environment in the early life-history of the individual. This habit is said to be not inheritable and can largely be corrected by a copious thinning of the fruits during the bearing year to prevent complete exhaustion. There is an interesting illustration of a graft apple tree, half "Gravenstein" and half "Russian," in which the two halves, for some unaccountable reason, have chosen two opposite years for their heavy crop, with the result that in one year one half is loaded with fruits and in the succeeding year the other half.

Yours faithfully,

Coimbatore, T. S. Venkataraman.

The 18th July, 1919. *Ag. Govt. Sugarcane Expert.*

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. Lawson's Text-Book of Botany (Indian edition). Revised and adapted by Birbal Sahni and M. Willis. With a preface by Dr. J. C. Willis. New and revised edition. Pp. xii+610. (London : W. B. Clive, University Tutorial Press.) Price, 8*s*. 6*d*.
2. Botany of the Living Plant, by F. O. Bower. Pp. x+580. (London : Macmillan & Co.) Price, 25*s*. net.
3. The Strawberry in North America—History, Origin, Botany, and Breeding, by Professor S. W. Fletcher. Pp. xiv+234. (London : Macmillan & Co.) Price, 8*s*. net.
4. Practical Physiological Chemistry, by S. W. Cole. With an introduction by Professor F. G. Hopkins. Fifth edition. Pp. xvi+401. (Cambridge : W. Heffer & Sons, Ltd.; London : Simpkin, Marshall, Ltd.) Price, 15*s*. net.
5. Productive Agriculture, by Professor J. H. Gehres. Pp. xii+436. (London : Macmillan & Co.) Price, 5*s*. 6*d*. net.
6. Irrigation Engineering, by Dr. A. P. Davis and H. M. Wilson. Seventh edition. Pp. xxiii+640. (New York : J. Wiley & Sons, Inc.; London : Chapman & Hall.) Price, 21*s*. net.
7. Practical Butter-making, by C. W. Walker-Tisdale and T. R. Robinson. Fourth revision. Pp. 143. (London : Headley Bros.) Price, 5*s*. 6*d*. net.
8. The Preparation of Substances important in Agriculture, by Prof. C. A. Peters. Third edition. Pp. vii+81. (New York : J. Wiley & Sons, Inc.; London : Chapman & Hall.) Price, 4*s*. net.

9. An Introduction to the Study of Biological Chemistry, by S. B. Schryver, D.Sc. Modern Outlook Series. Pp. 340. (London : J. C. and E. C. Jack.) Price, 6*s.* net.

10. Co-operation in Danish Agriculture, by Harold Faber, an English adaptation of *Andelsbevaegelsen i Denmark*, by H. Hartel, with a foreword by E. J. Russell. Pp. xxii+176. (London : Longmans Green & Co.) Price, 8*s.* 6*d.* net.

11. The Modern Milk Problem in Sanitation, Economics, and Agriculture, by J. S. MacNutt. Pp. xi+258+xvi plates. (London : Macmillan & Co.) Price, 10*s.* 6*d.* net.

12. Peach-growing, by H. P. Gould. Pp. xxi+426+xxxii plates. (London : Macmillan & Co.) Price, 10*s.* 6*d.* net.

13. Elementary Chemistry of Agriculture, by S. A. Woodhead. Pp. 188. (London : Macmillan & Co.)

14. Hints to Farm Pupils, by E. W. Lloyd. Pp. 112. (London : John Murray.) Price, 2*s.* 6*d.* net.

15. Co-operation for Farmers, by L. Smith Gordon. Pp. 247. (London : Williams & Norgate.) Price, 6*s.* net.

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue :—

Memoirs.

1. Studies in Indian Sugarcanes, No. 4. Tillering or underground branching, by C. A. Barber, C.I.E., Sc.D., F.L.S. (Botanical Series, Vol. X, No. 2.) Price, Rs. 4-4 or 7*s.*

2. Studies in Indian Sugarcanes, No. 5. On testing the suitability of sugarcane varieties for different localities, by a system of measurements. Periodicity in the growth of the sugarcane, by C. A. Barber, C.I.E., Sc.D. F.L.S. (Botanical Series, Vol. X, No. 3.) Price, R. 1-12 or 3*s.*

3. The Phosphate Requirements of some Lower Burma Paddy Soils, by F. J. Warth, M.Sc., B.Sc.; and Maung Po Shin. (Chemical Series, Vol. V, No. 5.) Price, R. 1-12 or 3*s.* 3*d*

Bulletins.

1. Cawnpore-American Cotton: An Account of Experiments in its Improvement by Pure Line Selection and of Field Trials, 1913–1917, by B. C. Burt, B.Sc., and Nizamuddin Haider. (Bulletin No. 88.) Price, As. 10 or 1*s*.
2. Resham-shilper unnatikalpé tuntbhook resham keetjáti sambandhe parikshar dwitiya bibaranee, by M. N. De. (Bengalee version of Pusa Bulletin No. 74 on "Second Report on the Experiments carried out at Pusa to Improve the Mulberry Silk Industry.") Price, As. 12 or 1*s*.

Reports.

1. Proceedings of the Second Meeting of Mycological Workers in India, held at Pusa on the 20th February, 1919, and following days. Price, As. 11 or 1*s*.
2. Proceedings of the First Meeting of Veterinary Officers in India, held at Lahore on the 24th March, 1919, and following days (with Appendices). Price, As. 8 or 9*d*.

INDEX TO VOL. XIV

1919

A

D

R

PAGE

W

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST FEBRUARY TO 31ST JULY, 1919.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	The *Agricultural Journal of India*, Vol. XIV, Parts II & IV. Price Rs. 2 or 3*s.*; annual subscription, Rs. 6 or 8*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India.	Messrs. Thacker, Spink & Co., Calcutta.
2	Special Indian Science Congress Number (1919) of the Agricultural Journal of India, Vol. XIV, Part III. Price Rs. 2 or 3*s.*	Ditto	Ditto
3	Progress of the sugarcane industry in India during the years 1916 and 1917. Being notes submitted to the meeting of the Board of Agriculture in India, Poona, 1917. Pusa Agricultural Research Institute Bulletin No. 83. Price As. 5 or 6*d.*	Edited, with an introduction, by C. A. Barber, C.I.E., SC.D., F.L.S., Chairman of the Sugar Committee of the Board of Agriculture in India, 1917.	Government Printing India, Calcutta.
4	Cawnpore-American cotton: An account of experiments in its improvement by pure line selection and of field trials, 1913-1917. Pusa Agricultural Research Institute Bulletin No. 88. Price As. 10 or 1*s.*	B. C. Burt, B.SC., Deputy Director of Agriculture, Central Circle, United Provinces, Cawnpore; and Nizamuddin Haider, Subordinate Agricultural Service, United Provinces.	Ditto.
5	Annual Report of the Board of Scientific Advice for India for the year 1917-18. Price As. 14 or 1*s.* 3*d.*	Issued by the Board of Scientific Advice for India.	Ditto.
6	Agricultural Statistics of India, 1916-17, Vol. I. Price Rs. 2 or 3*s.* 6*d.*	Issued by the Department of Statistics, India.	Ditto.
7	Agricultural Statistics of India, 1916-17, Vol. II. Price R. 1.	Ditto	Ditto.
8	Agricultural Statistics of British India, 1917-18. Price As. 4 or 5*d.*	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
9	Agricultural Statistics of Bengal for 1917-18. Price R. 1-8 or 2*s.* 3*d.*	Issued by the Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.
10	Season and Crop Report of Bengal for 1918-19. Price R. 1-5.	Issued by the Department of Agriculture, Bengal.	
11	Rules for the organization of Village Agricultural Associations (English).	Ditto ..	Ditto.
12	Departmental Records: Some suggestions as to the organization of agricultural exhibition in Bengal (Reprinted) (for official use only).	E. J. Woodhouse, Economic Botanist, Bengal.	Ditto.
13	Season and Crop Report of Bihar and Orissa for 1918-19. Price R. 1 or 1*s.* 4*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
14	Agricultural Statistics of Bihar and Orissa for 1917-18. Price As. 12 or 1*s.*	Ditto ..	Ditto.
15	Notes on improved methods of cane cultivation. United Provinces Department of Agriculture Bulletin No. 35 (Revised).	G. Clarke, F.I.C., Agricultural Chemist, United Provinces, and Naib Hussain.	Government Press, United Provinces, Allahabad.
16	Report on the Lawrence Gardens, Lahore, for 1918-19. Price As. 2 or 2*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
17	Annual Report of the Department of Agriculture, Bombay, for 1917-18. As. 12 or 1*s.* 2*d.*	Issued by the Department of Agriculture, Bombay.	Yeravda Prison Press, Poona.
18	First Report on Fruit culture as practised round about Tharushah (Sind) in Nawabshah District. Bombay Dept. of Agriculture Bulletin No. 88 of 1918. Price As. 2 or 2*d*	Mahamed Umar Khan F. Barakyai, D. AG., Agricultural Department, Sind.	Ditto.
19	Artificial manures: Experiments on their value for crops in Western India, No. II. Bombay Department of Agriculture Bulletin No. 89 of 1918. Price As. 3-3p. or 4*d.*	Harold H. Mann, D.SC., Principal, Poona Agricultural College, and S. R. Paranjpe, B.Ag.	Ditto.
20	The cultivation of Cape gooseberry or *Tiparee.* Bombay Department of Agriculture Leaflet No. 9 of 1918.	Issued by the Department of Agriculture, Bombay.	Ditto.